



FIFTY-NINTH ANNUAL REPORT
OF THE
SECRETARY
OF THE
State Board of Agriculture
OF THE
STATE OF MICHIGAN
AND
THIRTY-THIRD ANNUAL REPORT
OF THE
EXPERIMENT STATION
FROM
JULY 1, 1919, TO JUNE 30, 1920



BY AUTHORITY

LANSING, MICHIGAN
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REPORT OF THE SECRETARY
OF THE
STATE BOARD OF AGRICULTURE

EAST LANSING, MICH., *July 1, 1920.*

TO HON. ALBERT E. SLEEPER,

Governor of the State of Michigan:

Sir—I have the honor to submit to you herewith, as required by law, the accompanying report for the fiscal year ending June 30, 1920, with supplementary papers.

Very respectfully,

ADDISON M. BROWN,
Secretary of the State Board of Agriculture.



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LESLIE H. COOLEGE, M. S., Assistant Professor of Bacteriology.

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The names of instructors whose resignations took effect between June 30th. and September 1st., 1920, do not appear below.

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FRANK A. SPRAGG, M. S., Instructor in Farm Crops.

SANTOINETTE C. ROBSON, A. B., Instructor in French.

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JUSTUS E. RISING, M. E., Instructor in Drawing and Design.

FLOYD E. FOGLE, B. S., in Agr., Instructor in Farm Mechanics.

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GODFREY L. RUEHLE, M. S., Research Asso. in Bacteriology.

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ARTHUR HOWLAND, Assistant in Dairying.

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JOHN E. KOTILA, B. S., Research Asst. in Plant Pathology.

* Deceased Oct. 22—1919

* Resigned

° Absent on leave

§ Deceased October 3—1919

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Elda Iantha Robb, B. S.	Assistant, Girls' Clubs.
Margaret Hatty	Assistant, Girls' Clubs.
Arne Gerald Kettunen, B. S.	District Club Leader, U. P.
William Anderson, B. S.	Assistant, Boys' Clubs.

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Clara May Waldron, B. S.	St. Clair.
Bernice Jennie Woodworth, B. S.	Allegan.
Jennie Williams, B. S.	Schoolcraft.
Flora E. McElhinney	Houghton.
Helen E. Simonson	Dickinson.
Helen Columbia Pratt, B. S.	Chippewa.
Sylvia Richardson	Delta.
Eva Carrett	Oakland.

ACCOUNT OF THE MICHIGAN AGRICULTURAL COLLEGE

FOR THE YEAR ENDING JUNE 30, 1920.

SECRETARY'S FINANCIAL REPORT.

July 1, 1919.	Cash on hand.....		\$6,489 66	
July 1, 1919.	Cash on Deposit College Treasurer.....		6,024 98	
June 30, 1920.	To special appropriation receipts.....		437,852 93	
	From State Treasurer.....	\$214,957 49		
	From United States Treasurer.....	163,224 23		
	From institution and other sources.....	59,674 21		
June 30, 1920.	By disbursements.....			\$409,455 97
	Special Appropriations.....	\$28,854 41		
	Experiment Station.....	169,718 17		
	Extension.....	210,883 39		
June 30, 1920.	To current account receipts.....		\$1,030,935 93	
	From State Treasurer, land grant interest.....	\$70,736 34		
	From State Treasurer, one-fifth mill tax.....	578,578 46		
		\$935,000 00		
	(a) 356,421 54			
	From United States Treasurer, Morrill Fund.....	50,000 00		
	From institution and other sources.....	331,621 13		
June 30, 1920.	By general account disbursements.....			1,007,814 55
June 30, 1920.	By cash on hand.....			11,039 63
June 30, 1920.	By cash on deposit.....			52,993 35
			\$1,481,303 50	\$1,481,303 50
(a)	Appropriated for Shops and Storehouse.....	\$15,000 00		
	Appropriated for Extension.....	75,797 46		
	Appropriated for Experiment Station.....	115,624 08		
	Balance with State Treasurer.....	150,000 00		

TABLE NO. 1.—*Tabular Exhibit of Secretary's Reports.*

	Balance sheet July 1, 1919.		Transactions, July 1, 1919 to June 30, 1920.		Balance sheet June 30, 1920.	
	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Cash.....	\$6,489 66				\$11,039 63	
(a) College Treasurer.....	6,024 98				52,993 35	
Special Appropriations.....	2,381 78		\$43,138 29			
Current Accounts.....		\$29,209 50	1,030,935 93			\$11,702 10
Experiment Station.....	14,113 08		183,831 25			52,330 88
Extension.....			210,883 39			
Total.....	\$29,209 50	\$29,209 50	\$1,468,788 86	\$1,468,788 86	\$64,032 98	\$64,032 98
(a) Treasurer's statement is greater July 1, 1919 by \$18,641.34 and June 30, 1920 by \$65,553.24. Warrants outstanding less the amount of \$6,772.69 in transit.						
TREASURER'S ACCOUNT.						
			Dr.		Cr.	
Balance on hand July 1, 1919.....						
Receipts from State Treasurer and Secretary of the College.....					\$24,666 32	
Interest on deposits during the year.....					1,461,730 68	
Warrants paid July 1, 1919 to June 30, 1920.....					1,760 51	
Balance on hand June 30, 1920.....					\$1,376,383 61	
					111,773 90	
Total.....					\$1,488,157 51	
					\$1,488,157 51	

TABLE NO. 2.—Statement of special appropriation accounts for the fiscal year ending June 30, 1920.

	Balance of Accounts July 1, 1919.		Receipts.		Total available.	Total expended.	Balance of Accounts June 30, 1920.	
	Dr.	Cr.	From State Treasurer.	From Institution and other sources.			Dr.	Cr.
Experiment Station.....	\$14,113 08		(a)\$145,024 08	\$38,189 73	\$169,718 17	\$169,718 17		
Extension.....			(b)209,018 69	1,878 73	210,883 39	210,883 39		
Geo. L. Allen Scholarship.....		\$86 38		30 00	86 38			\$86 38
Lawson Memorial Prize.....				25 00	25 00			
Marilla Griswold Scholarship.....	12 50			2,110 00	2,110 00			
Nursery License.....				1,607 00	1,607 00			
Sayer Fund.....		12 20		25 00	37 20			
Shops and Storehouse.....	1,297 44		15,000 00		13,702 56	14,730 00	1,088 36	12 20
U. S. Army School.....	2,846 54				12,958 80	9,394 92		12,618 83
Vocational Teacher Training.....		1,134 73	8,535 95	15,785 31	9,670 68	9,324 48	254 30	
Weather Service.....		391 39			391 39	177 71		213 68
Totals.....	\$18,269 56	\$1,574 70	\$378,178 72	\$59,670 80	\$421,458 07	\$409,455 97	\$1,355 16	\$13,057 26

(a) \$30,000.00 United States Treasurer.

(b) \$133,221.23 United States Treasurer.

TABLE NO. 3.—*William Smith Sayer Scholarship Fund.*

	Year ending June 30.	Income.	Income expended to	Amount	Balance including principal.
\$500.00 received of F. F. Sayer, administrator of the estate of William Smith Sayer, to establish Scholarship in Bacteriology.....	1910	\$32 25	A. McVittie.....	\$19 75	\$512 20
	1911	37 50			550 00
	1912	12 50	D. K. Fisher.....	25 00	512 50
	1913	25 00	H. K. Wright.....	25 00	512 50
	1914	24 85	D. Francisco.....	25 00	512 35
	1915	24 85	R. W. Waffle.....	25 00	512 20
	1916	25 00	J. D. Baker.....	25 00	512 20
	1917	25 00	J. M. Maze.....	25 00	512 20
	1918	25 00	Elsa Scheuren.....	25 00	537 20
	1919	25 00	Elwyn Younker.....	25 00	512 20
	1920	25 00	Ethel Hopphan.....	25 00	512 20
Total.....		\$281 95		\$269 75	

TABLE NO. 4.—*Geo. E. Lawson Memorial Prize.*

	Year ending June 30.	Income.	Income expended to	Amount	Balance including principal.
\$500 received of John W. Beaumont, in memory of Geo. E. Lawson, to offer annual cash prize for the best essay in English produced by male student.....	1917	\$25 00	I. B. McMurtry...	\$25 00	\$500 00
	1918	12 50	H. C. Diehl.....	25 00	487 50
	1919	25 00	Stanley Powell...	25 00	487 50
	1920	25 00	Fred F. Henshaw..	25 00	487 50
Total.....		\$87 50		\$100 00	

TABLE NO. 5.—*Geo. L. Allen Scholarship.*

	Year ending June 30.	Income.	Income expended.	Amount.	Balance including principal.
\$1,000 received of Amanda A. Ransom to be used in assisting the poor and deserving young men in obtaining their education.....	1919	\$36 38			\$1,036 38
	1920	50 00			1,086 38
Total.....		\$86 38			

TABLE NO. 6.—*Marilla Griswold Scholarship.*

	Year ending June 30.	Income.	Income expended.	Amount.	Balance including principal.
\$2,000 received of Orion S. Cross, Executor of the Estate of Marilla Griswold, the income of the same to be used under the direction of the State Board of Agriculture to help needy students. Preference to be given to those from Allegan County.....					
	1920	\$96 17			\$2,096 17

TABLE NO. 7.—*Current Account July 1, 1919, to June 30, 1925.*

On account of—	Dr. To disburse- ments.	Cr. By receipts.
U. S. Treasurer, 30th Annual Payment under Act of Congress, of August, 1890.....		\$50,000 00
State Treasurer, one-fifth mill fund.....		578,578 46
State Treasurer, interest on proceeds of sales of U. S. land grant.....		70,736 34
Agricultural Education.....	\$760 82	20 08
Anatomy.....	1,001 62	397 48
Animal Husbandry.....	24,354 10	19,225 53
Bacteriology.....	9,709 51	2,816 02
Botany.....	4,303 87	1,653 18
Chemistry.....	17,650 09	11,749 06
Civil Engineering.....	2,623 80	618 00
Dairy Husbandry.....	103,925 94	99,373 98
Drawing.....	2,042 68	970 91
Domestic Art.....	3,712 27	2,025 22
Domestic Science.....	7,273 11	2,243 83
Economics.....	207 66	13 00
Electrical Engineering.....	3,174 50	274 12
English.....	1,754 95	31 00
Entomology.....	2,526 19	479 24
Farm Crops.....	5,559 95	317 16
Farm and Horses.....	31,376 86	24,112 30
Farm Mechanics.....	7,143 41	1,261 64
Forestry.....	4,570 92	2,618 95
History.....	127 75	2 00
Horticulture.....	8,072 03	3,227 63
Library.....	3,201 00	19 48
Mathematics.....	1,521 62	180 25
Mechanical Engineering.....	21,075 59	4,648 73
Meteorology.....	1 00	4 00
Military Science.....	6,058 73	161 05
Music.....	1,113 49	755 50
Pathology.....	614 12	57
Physical Training.....	11,054 19	5,216 45
Physics.....	6,646 79	2,573 59
Poultry.....	9,295 13	2,767 26
Soils.....	3,476 01	292 23
Special Courses.....	15,285 06	4,079 70
Surgery and Clinic.....	5,272 56	506 05
Veterinary Science.....	869 40	98 06
Zoology.....	1,445 51	506 50
Advertising.....	4,614 69	
Alumni Recorder.....	2,360 60	33 56
Board Members Expense.....	488 86	75
Bulletins.....	11 12	
Cleaning.....	18,522 25	1,626 91
Commencement.....	531 81	
Convocations.....	347 15	
Dean of Agriculture.....	1,012 71	
Dean of Engineering.....	629 34	
Dean of Women.....	14,585 14	614 91
Dean of Summer School.....	459 87	
Diploma.....	1,348 93	1,303 50
Electric Lighting.....	12,521 32	3,542 78
Federal Students.....	3,254 66	4,705 73
Fire Equipment.....	18 69	
Freight and Cartage.....	6,022 41	768 91

TABLE NO. 7.—*Current Account July 1, 1919 to June 30, 1920.*—Concluded.

On account of —	Dr. To disburse- ments.	Cr. By receipts.
General.....	\$18,357 43	648 99 373 20
General Lectures.....	32 00	
Heating.....	77,898 44	258 23
Hospitals.....	6,962 07	1,548 94
Land Improvements.....	2,009 00	
Maintenance of Grounds.....	8,034 84	
Maintenance and Repair of Buildings.....	55,502 73	15,607 77
Miscellaneous.....	23 91	1 35
New Buildings and Additions.....	1,625 91	
Office, President's.....	4,657 52	1,340 03
Office, Secretary's.....	7,415 56	3,053 98
Registrar.....	2,047 02	10 72
Salaries.....	126,062 18	2,442 39
Seed Analysis.....	369 70	
Telephones.....	1,781 46	147 66
Total.....	\$1,007,811 55	\$1,030,935 94
Balance beginning fiscal year, July 1, 1919.....		29,209 50
Balance on hand June 30, 1920.....	52,330 88	
Total.....	\$1,060,145 43	\$1,060 145 43

(a) Rental, \$1,208.00; labor, \$392.87; supplies, \$1,003.24; incidental, \$59,095.00; tuition, \$6,115.00; matriculation, \$3,030.00; room rent, \$25,358.30; books, \$176.66; sundry, \$425.62; interest, \$1,760.51; diploma, \$10.00; delinquent, \$798.00.

STATE BOARD OF AGRICULTURE.

DISTRIBUTION OF SPECIAL APPROPRIATIONS.

	Dr. to disburse- ments.	Cr. by receipts.
Weather Service.....	\$177 71	.....
Nursery License and Inspection.....	1,607 00	\$1,607 00
Sayer Fund.....	25 00	25 00
Geo. E. Lawson Memorial Prize.....	25 00	25 00
Geo. L. Allen Scholarship.....	.....	50 00
Marilla Griswold Scholarship.....	2,013 83	2,110 00
Shops and Storehouse.....	14,790 92	15,000 00
U. S. Army School.....	289 97	15,785 34
Vocational Teacher Training.....	9,921 98	8,535 95
Total.....	\$28,854 11	\$43,138 29
Balance overdrawn beginning fiscal year July 1, 1919	2,581 78	.....
Balance on hand June 30, 1920.....	11,702 10	.....
Total.....	\$43,138 29	\$43,138 29

TABLE NO. 8.—*Experiment Station Account for Fiscal Year ending June 30, 1920.*

	Disbursements.			Dr. total disburse- ments each de- partment.	Cr. by receipts.
	Adams.	Hatch.	State.		
Balance overdrawn July 1, 1919.....				\$44,113 08	
United States Treasurer.....					\$20,000 00
State Treasurer, one-fifth mill fund.....					115,624 08
Fertilizer fees.....			\$1,333 52	1,333 52	8,241 00
Commercial Feeding Stuffs.....			1,547 93	1,547 93	17,580 00
Animal Husbandry.....			1,005 99	1,005 99	15 43
Bacteriological.....			7,943 31	7,943 31	45 45
Botanical.....			5,138 87	5,138 87	37 05
Chemical.....			4,663 55	4,663 55	47 52
Dairy Husbandry.....			2,558 66	2,558 66	252 80
Director's Office.....			11,030 17	11,030 17	51 64
Entomological.....		\$44 55	1,501 88	1,516 43	83
Farm Crops.....			6,168 52	6,168 52	779 98
Farm Mechanics.....			174 40	174 40	
Forestry.....			353 05	353 05	
Graham Horticulture.....			4,237 31	4,237 31	1,473 43
Home Economics.....			17 44	17 44	47 44
Horticulture.....			3,061 62	3,061 62	179 31
Library.....			209 76	209 76	
Poultry.....			21 69	21 69	24 69
Salaries.....	\$15,000 00	14,985 45	50,494 78	80,480 23	
Secretary's Office.....					42 17
Soils.....			4,761 40	4,761 40	18 77
South Haven Experiment Sta- tion.....			2,218 29	2,218 29	778 96
Upper Peninsular Experiment Station.....			31,276 00	31,276 00	8,623 70
Balance on hand June 30, 1920.....					
Total.....	\$15,000 00	\$15,000 00	\$139,718 17	\$183,831 25	\$183,831 25

TABLE NO. 9.—*Extension Account for Fiscal year ending June 30, 1920.*

	Disbursements.			Dr. total disburse- ments for each project.	Cr. by receipts.
	Lever.	Lever State.	State.		
Balance July 1, 1919.....					\$133,221 23
U. S. Treasurer, Lever fund.....					
State Treasurer, one-fifth mill, Lever state.....					71,986 78
State Treasurer, one-fifth mill, fund state.....					3,810 68
Administration.....	\$2,100 42	\$8,146 06	\$51 37	10,597 85	208 97
Boys' and Girls' Club Work.....	17,191 13	9,649 94	406 11	27,250 18	14 31
County Agents.....	71,176 12	9,573 91	944 03	81,694 36	200 86
Control Insect Pests.....	1,620 01	2,573 79	38 63	4,232 43	32
Dairy Products.....	51 48	454 80	56 78	563 06	
Extension Schools.....	200 16	1,869 80	642 32	2,712 28	
Farm Management Demon- stration.....	1,362 25	609 26	100 05	2,071 56	219 20
Farmers Week.....			3 55	3 55	
Farm Crops.....	3,637 67	5,554 74	164 27	9,356 68	
Home Demonstration Agents.....	15,362 77	2,923 75		18,286 52	34 37
Home Economics.....	4,285 21	6,362 30	487 12	11,134 63	936 83
Household Engineering.....	705 81	1,875 38	78 67	2,659 86	
Horticulture.....	1,211 41	1,892 18	72 42	3,206 01	35 21
Live Stock.....	2,436 90	1,750 94	135 13	4,322 97	13 56
Muck Crops.....	1,821 68	2,076 13	103 26	4,001 07	
Forestry.....	503 12	900 00		1,403 12	
Markets.....	3,991 95	5,403 15	494 07	9,889 17	
Potatoes and Vegetables.....	1,663 88	4,738 67	26 22	6,428 77	
Poultry.....	2,087 19	3,015 48	205 40	5,338 07	196 01
Printing and Distribution of Publications.....	974 38	1,916 45	880 77	3,771 60	5 00
Soils.....	886 08	1,073 57		1,959 65	
Total.....	\$133,602 92	\$72,390 30	\$4,890 17	\$210,883 39	\$210,883 39

TABLE NO. 10.—*Positions and salaries as shown by pay-roll dated June 30, 1926.*

	Rate per year.	Classification.		Extension.
		Current.	Experiment Station.	
Administration and miscellaneous:				
President's Office:				
President	\$7,000 00	\$7,000 00		
Clerk to President	2,600 00	2,600 00		
Secretary to President	1,500 00	1,500 00		
Secretary's Office:				
Secretary	4,100 00	\$3,400 00	\$700 00	
Cashier	3,200 00	2,700 00	500 00	
Bookkeeper	1,500 00	1,300 00	200 00	
Chief Clerk	2,300 00	550 00		81,750 00
Stenographer	1,200 00	1,200 00		
Clerk	1,200 00	1,200 00		
Clerk	1,200 00	1,200 00		
Clerk	1,200 00	1,200 00		
Purchasing Agent	2,600 00	2,600 00		
Registrar's Office:				
Registrar	2,600 00	2,600 00		
Assistant	1,500 00	1,500 00		
Clerk	1,200 00	1,200 00		
Alumni Office:				
Alumni Recorder	3,750 00	3,750 00		
Assistant Recorder	1,500 00	1,500 00		
Library:				
Librarian	2,400 00	2,000 00	400 00	
Assistant Librarian	1,600 00	1,600 00		
Miscellaneous:				
Engineer	2,500 00	2,500 00		
Night Watchman	1,200 00	1,200 00		
Architect	3,500 00	3,500 00		
Stenographer	975 00	975 00		
Stenographer	1,300 00	1,300 00		
Stenographer	1,200 00	1,200 00		
Medical Officer	1,400 00	1,400 00		
College Nurse	1,200 00	1,200 00		
Employment Bureau	500 00	500 00		
Instructor in Meteorology	600 00	600 00		
Division of Home Economics:				
Dean's Office:				
Dean of Home Economics	2,800 00	2,800 00		
Dean of Women	3,300 00	3,300 00		
Stenographer	1,350 00	1,350 00		
Department of Domestic Art:				
Professor	3,250 00	3,250 00		
Assistant Professor	2,200 00	2,200 00		
Assistant Professor	2,200 00	2,200 00		
Assistant Professor	2,200 00	2,200 00		
Instructor	1,600 00	1,600 00		
Instructor	1,600 00	1,600 00		
Instructor	1,000 00	1,000 00		
Department of Domestic Science:				
Associate Professor	2,600 00	2,600 00		
Assistant Professor	2,200 00	2,200 00		
Assistant Professor	2,200 00	2,200 00		
Instructor	1,800 00	1,800 00		
Instructor	1,600 00	1,600 00		
Miscellaneous:				
Director Women's Dormitories	2,600 00	2,600 00		
House Mother	1,200 00	1,200 00		
Hostess Abbott Hall	940 00	940 00		
Matron College Cottage	850 00	850 00		
Matron College Residence	1,350 00	1,350 00		
Matron Collingwood House	550 00	550 00		
Instructor Physical Culture and Assist- ant to Dean	1,600 00	1,600 00		

TABLE NO. 10 - *Continued.*

	Rate per year.	Classification.		Extension.
		Current.	Experiment Station.	
Division of Engineering:				
Dean's Office:				
Dean.....	\$1,200 00	*\$4,200 00		
Clerk.....	1,350 00	1,350 00		
Department of Drawing and Design:				
Professor.....	3,750 00	3,750 00		
Associate Professor.....	2,800 00	2,800 00		
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Instructor.....	2,200 00	2,200 00		
Instructor.....	2,000 00	2,000 00		
Instructor.....	1,800 00	1,800 00		
Instructor.....	1,800 00	1,800 00		
Instructor.....	1,600 00	1,600 00		
Instructor.....	2,000 00	2,000 00		
Stenographer.....	1,300 00	1,300 00		
Department of Civil Engineering:				
Professor.....	3,450 00	*3,450 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,100 00	2,100 00		
Department of Mechanical Engineering:				
Professor.....	3,750 00	3,750 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Instructor.....	2,200 00	2,200 00		
Foreman Machine Shop.....	2,400 00	2,400 00		
Foreman Wood Shop.....	2,200 00	2,200 00		
Foreman Foundry.....	2,200 00	2,200 00		
Instructor Forge Shop.....	2,200 00	2,200 00		
Instructor Wood Shop.....	2,000 00	2,000 00		
Pattern Maker.....	1,800 00	1,800 00		
Tool Room Attendant.....	1,700 00	1,700 00		
Shop Engineer.....	1,500 00	1,500 00		
Electrical Engineering Department:				
Professor.....	3,750 00	3,750 00		
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
Division of Science and Letters:				
Department of Bacteriology:				
Professor.....	3,750 00	3,050 00	\$700 00	
Associate Professor.....	2,600 00	2,200 00	400 00	
Assistant Professor.....	2,400 00	1,400 00	1,000 00	
Assistant Professor.....	2,800 00	1,300 00	1,500 00	
Instructor.....	2,000 00	2,000 00		
Graduate Assistant.....	500 00	500 00		
Research Associate in Bacteriology.....	2,800 00		2,800 00	
Research Associate in Bacteriology.....	2,700 00		2,700 00	
Research Assistant in Bacteriology.....	2,400 00		2,400 00	
Research Assistant in Bacteriology.....	2,400 00		2,400 00	
Stenographer.....	1,200 00	1,200 00		
Department of Botany:				
Professor.....	3,450 00	*2,800 00	650 00	
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Instructor.....	2,000 00	2,000 00		
Instructor.....	2,000 00	2,000 00		
Instructor.....	2,600 00	1,200 00	1,350 00	
Graduate Assistant, one-half time.....	500 00	500 00		
Associate Professor in Plant Pathology.....	3,200 00	1,750 00	1,450 00	
Research Assistant in Plant Pathology.....	2,400 00		2,400 00	
Assistant in Plant Pathology.....	2,600 00		2,600 00	
Research Associate in Plant Physiology.....	3,000 00	1,250 00	1,750 00	
Stenographer.....	1,300 00	1,300 00		

TABLE NO. 10—Continued.

	Rate per year.	Classification.		Extension.
		Current.	Experiment Station.	
Department of Chemistry:				
Professor.....	\$3,750 00	\$3,750 00		
Associate Professor.....	3,200 00	3,200 00		
Associate Professor.....	3,200 00	3,200 00		
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Instructor.....	2,200 00	2,200 00		
Instructor.....	2,200 00	2,200 00		
Instructor.....	2,200 00	2,200 00		
Instructor.....	2,000 00	2,000 00		
Instructor.....	2,000 00	2,000 00		
Instructor.....	2,000 00	2,000 00		
Instructor.....	1,900 00	1,900 00		
Dispensing Clerk.....	1,500 00	1,500 00		
Department of English:				
Professor.....	3,450 00	*3,450 00		
Associate Professor.....	2,800 00	2,800 00		
Associate Professor.....	2,800 00	2,800 00		
Associate Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,200 00	2,200 00		
Assistant Professor, one-half time.....	1,200 00	1,200 00		
Instructor.....	2,200 00	2,200 00		
Instructor.....	1,800 00	1,800 00		
Instructor.....	1,800 00	1,800 00		
Instructor.....	1,400 00	1,400 00		
Instructor.....	1,200 00	1,200 00		
Department of Economics:				
Professor.....	3,750 00	3,750 00		
Associate Professor.....	3,000 00	3,000 00		
Associate Professor.....	1,300 00	1,300 00		
Department of Entomology:				
Professor.....	3,450 00	2,600 00	\$850 00	
Assistant Professor.....	2,200 00	1,800 00	400 00	
Assistant Professor.....	3,000 00	1,000 00	2,000 00	
Instructor.....	900 00	900 00		
Inspector Apiaries and Instructor Bee-Keeping.....	800 00	800 00		
Department of History:				
Professor.....	3,750 00	3,750 00		
Assistant Professor.....	2,200 00	2,200 00		
Instructor.....	1,500 00	1,500 00		
Department of Mathematics:				
Professor.....	3,750 00	3,750 00		
Associate Professor.....	3,000 00	3,000 00		
Assistant Professor.....	2,500 00	2,500 00		
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Instructor.....	2,200 00	2,200 00		
Instructor.....	1,800 00	1,800 00		
Department of Military Science:				
Professor.....	1,950 00	1,950 00		
Instructor.....	920 00	920 00		
Department of Music:				
Musical Director.....	3,200 00	3,200 00		
Department of Physical Culture:				
Director.....	4,500 00	4,500 00		
Instructor Physical Training.....	2,200 00	2,200 00		
Instructor Physical Training.....	1,800 00	1,800 00		

TABLE NO. 10—Continued.

	Rate per year.	Classification.		Extension.
		Current.	Experiment Station.	
Department of Physics:				
Professor.....	\$3,750 00	\$3,750 00		
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
College Photographer.....	1,800 00	1,800 00		
Laboratory Assistant and Clerk.....	900 00	900 00		
Caretaker.....	1,100 00	1,100 00		
Department of Zoology:				
Professor.....	3,450 00	3,450 00		
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
Instructor.....	2,300 00	2,300 00		
Instructor.....	2,200 00	2,200 00		
Instructor.....	2,200 00	2,200 00		
Division of Veterinary Science:				
Veterinary Department:				
Acting Dean.....	4,200 00	4,200 00		
Assistant Professor.....	2,400 00	2,400 00		
Stenographer.....	1,200 00	1,200 00		
Department of Anatomy:				
Assistant Professor.....	2,600 00	2,600 00		
Department of Pathology:				
Associate Professor.....	3,450 00	2,800 00	\$650 00	
Assistant Professor.....	2,400 00	2,400 00		
Department of Surgery and Clinic:				
Associate Professor.....	3,400 00	3,400 00		
Assistant Professor.....	2,400 00	2,400 00		
Division of Agriculture:				
Dean's Office:				
Dean.....	4,200 00	2,700 00	1,500 00	
Stenographer.....	1,350 00	1,000 00	350 00	
Department of Animal Husbandry:				
Professor.....	3,750 00	3,350 00	400 00	
Instructor.....	2,400 00	2,400 00		
Herdsmen.....	1,800 00	1,800 00		
Department of Dairy Husbandry:				
Professor.....	3,750 00	3,100 00	650 00	
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
Instructor.....	2,200 00	2,200 00		
Instructor Cheesemaking.....	1,500 00	1,500 00		
Superintendent Advanced Registry.....	1,800 00	1,800 00		
Clerk.....	1,300 00	1,300 00		
Clerk, Junior.....	1,200 00	1,200 00		
Assistant in Dairying.....	2,400 00		2,400 00	
Assistant in Dairying.....	2,200 00		2,200 00	
Assistant in Dairying.....	1,350 00		1,350 00	
Field Accountant in Dairying.....	1,350 00		1,350 00	
Department of Farm Crops:				
Professor.....	3,750 00	3,050 00	700 00	
Assistant Professor.....	2,800 00	900 00		\$1,900 00
Assistant Professor.....	2,400 00	1,900 00	500 00	
Assistant Professor.....	1,800 00	1,800 00		
Instructor.....	3,200 00	1,250 00	1,950 00	
Stenographer.....	1,200 00	1,200 00		
Farm Crops Breeder.....	2,300 00	1,300 00	1,000 00	
Assistant Farm Crops.....	2,200 00	2,200 00		
Assistant Farm Crops.....	2,200 00	1,000 00	1,200 00	
Assistant Farm Crops.....	1,800 00		600 00	1,200 00
Graduate Assistant.....	500 00	500 00		

TABLE NO. 10—Continued.

	Rate per year.	Classification.		Extension.
		Current.	Experiment Station.	
Department of Farm Mechanics:				
Acting Professor.....	\$3,450 00	\$3,450 00		
Assistant Professor.....	2,400 00	1,350 00	\$1,050 00	
Instructor.....	2,000 00	1,000 00	1,000 00	
Blacksmith and Horseshoer.....	1,800 00	1,800 00		
Tool Room Attendant.....	1,800 00	1,800 00		
Department of Farm and Horses:				
Superintendent.....	2,400 00	2,400 00		
Department of Poultry:				
Professor.....	3,750 00	3,150 00	600 00	
Assistant Professor.....	1,800 00	600 00	1,200 00	
Poultryman.....	1,200 00	1,200 00		
Department of Forestry:				
Professor.....	3,750 00	3,300 00	450 00	
Associate Professor.....	2,800 00	2,800 00		
Assistant Professor.....	2,400 00	2,400 00		
Nursery Foreman.....	1,700 00	1,700 00		
Department of Horticulture:				
Professor.....	3,750 00	3,050 00	700 00	
Assistant Professor.....	2,400 00	2,400 00		
Assistant Professor.....	2,400 00	2,100 00	300 00	
Assistant Professor.....	2,500 00	2,500 00		
Assistant in Horticulture.....	2,400 00		2,400 00	
Stenographer.....	1,200 00	1,200 00		
Department of Soils:				
Professor.....	3,750 00	2,900 00	850 00	
Associate Professor.....	2,800 00	2,000 00	800 00	
Assistant Professor.....	2,600 00	1,550 00	1,050 00	
Assistant Professor.....	2,800 00	1,800 00		\$1,000 00
Instructor.....	2,200 00	1,800 00	400 00	
Instructor.....	1,800 00	900 00	900 00	
Research Associate in Soils.....	3,000 00		3,000 00	
Research Assistant in Soils.....	2,800 00		1,400 00	1,400 00
Stenographer.....	1,200 00	1,200 00		
Special Courses:				
Director.....	2,000 00	2,000 00		
Experiment Station Chemistry:				
Chemist.....	3,750 00		3,750 00	
Research Assistant in Chemistry.....	3,000 00		3,000 00	
Research Assistant in Chemistry.....	2,800 00		2,800 00	
Assistant in Chemistry.....	2,200 00		2,200 00	
Assistant in Chemistry.....	1,600 00		1,600 00	
Assistant in Chemistry.....	2,000 00		2,000 00	
Stenographer.....	1,350 00		1,350 00	
Chief Inspector.....	2,200 00		2,200 00	
Inspector in Fertilizer and Feeds.....	1,800 00		1,800 00	
Inspector in Fertilizer and Feeds.....	1,800 00		1,800 00	
Bulletin Clerk.....	1,200 00		1,200 00	
Division of Extension:				
Administration:				
Director.....	3,750 00			3,750 00
Clerk.....	1,500 00			1,500 00
Supervisor Publications.....	1,400 00			1,400 00
County Agents:				
State Leader.....	2,250 00			2,250 00
Assistant.....	1,700 00			1,700 00
Assistant.....	1,800 00			1,800 00
Assistant.....	1,200 00			1,200 00
Stenographer.....	1,500 00			1,500 00
Stenographer.....	1,200 00			1,200 00
Agent, Allegan County.....	1,200 00			1,200 00
Agent, Alpena County.....	1,200 00			1,200 00
Agent, Antrim County.....	1,200 00			1,200 00
Agent, Baraga County.....	1,200 00			1,200 00

TABLE NO. 10—Continued.

	Rate per year.	Classification.		Extension.
		Current.	Experiment Station.	
County Agents.—Concluded:				
Agent, Benzie County.....	\$1,200 00			\$1,200 00
Agent, Branch County.....	1,200 00			1,200 00
Agent, Calhoun County.....	1,200 00			1,200 00
Agent, Cass County.....	1,200 00			1,200 00
Agent, Charlevoix County.....	1,200 00			1,200 00
Agent, Cheboygan County.....	1,200 00			1,200 00
Agent, Chippewa County.....	1,200 00			1,200 00
Agent, Clinton County.....	1,200 00			1,200 00
Agent, Delta County.....	1,200 00			1,200 00
Agent, Eaton County.....	1,200 00			1,200 00
Agent, Emmet County.....	1,200 00			1,200 00
Agent, Genesee County.....	1,200 00			1,200 00
Agent, Gladwin County.....	1,200 00			1,200 00
Agent, Gogebic County.....	1,200 00			1,250 00
Agent, Grand Traverse County.....	1,200 00			1,200 00
Agent, Houghton County.....	1,200 00			1,200 00
Agent, Iron County.....	1,200 00			1,200 00
Agent, Jackson County.....	1,200 00			1,200 00
Agent, Kalamazoo County.....	1,200 00			1,200 00
Agent, Kalamazoo County.....	1,200 00			1,200 00
Agent, Kent County.....	1,200 00			1,200 00
Agent, Leapeer County.....	1,200 00			1,200 00
Agent, Livingston County.....	1,200 00			1,200 00
Agent, Luce County.....	1,200 00			1,200 00
Agent, Macomb County.....	1,200 00			1,200 00
Agent, Manistee County.....	1,200 00			1,200 00
Agent, Marquette County.....	1,200 00			1,200 00
Agent, Mecosta County.....	1,200 00			1,200 00
Agent, Menominee County.....	1,200 00			1,200 00
Agent, Missaukee County.....	1,200 00			1,200 00
Agent, Montcalm County.....	1,200 00			1,200 00
Agent, Muskegon County.....	1,200 00			1,200 00
Agent, Oakland County.....	1,200 00			1,200 00
Agent, Ogemaw County.....	1,200 00			1,200 00
Agent, Otsego County.....	1,200 00			1,200 00
Agent, Ottawa County.....	1,200 00			1,200 00
Agent, Saginaw County.....	1,200 00			1,200 00
Agent, Schoolcraft County.....	1,200 00			1,200 00
Agent, Shiawassee County.....	1,200 00			1,200 00
Agent, St. Clair County.....	1,200 00			1,200 00
Agent, St. Joseph County.....	1,200 00			1,200 00
Agent, Tuscola County.....	1,200 00			1,200 00
Agent, Van Buren County.....	1,200 00			1,200 00
Agent, Washtenaw County.....	1,200 00			1,200 00
Agent, Wayne County.....	1,200 00			1,200 00
Agent, Wexford County.....	1,200 00			1,200 00
Home Demonstration Agents:				
Assistant Leader.....	2,400 00			2,400 00
Agent, Schoolcraft County.....	1,000 00			1,000 00
Agent, Houghton County.....	1,000 00			1,000 00
Agent, Dickinson County.....	1,000 00			1,000 00
Agent, Chippewa County.....	1,000 00			1,000 00
Agent, Gogebic County.....	1,000 00			1,000 00
Agent, Allegan County.....	1,000 00			1,000 00
Agent, Kalamazoo County.....	1,000 00			1,000 00
Agent, Ottawa County.....	1,000 00			1,000 00
Agent, St. Clair County.....	1,000 00			1,000 00
Agent, Wayne County.....	1,000 00			1,000 00
Agent, Oakland County.....	1,000 00			1,000 00
Agent, Manistee County.....	1,000 00			1,000 00
Stenographer, Administration.....	1,200 00			1,200 00
Home Economics:				
Specialist.....	2,000 00			2,000 00
Specialist.....	2,000 00			2,000 00
Specialist.....	2,200 00			2,200 00
Stenographer.....	1,200 00			1,200 00

AGRICULTURAL COLLEGE ACCOUNTS.

31

TABLE NO. 10—*Concluded.*

	Rate per year.	Classification.		Extension.
		Current.	Experiment Station.	
Extension Schools:				
Supervisor.....	\$2,400 00			\$2,400 00
Boys' and Girls' Clubs:				
State Leader.....	1,620 00			1,620 00
Assistant.....	1,020 00			1,020 00
Assistant.....	1,900 00			1,900 00
Assistant.....	1,660 00			1,660 00
Assistant.....	1,800 00			1,800 00
Assistant in Girls' Clubs.....	1,600 00			1,600 00
Stenographer.....	1,200 00			1,200 00
Farm Crops:				
Assistant Specialist.....	2,500 00			2,500 00
Livestock:				
Specialist.....	1,200 00			1,200 00
Specialist.....	1,000 00			1,000 00
Horticulture:				
Specialist.....	2,400 00			2,400 00
Potatoes and Vegetables:				
Specialist.....	2,800 00			2,800 00
Specialist.....	2,100 00			2,100 00
Control Inspection:				
Assistant.....	1,400 00			1,400 00
Assistant.....	1,700 00			1,700 00
Markets:				
Specialist.....	700 00			700 00
Assistant.....	2,900 00			2,900 00
Assistant.....	2,700 00			2,700 00
Poultry:				
Specialist.....	2,300 00			2,300 00
Assistant.....	1,500 00			1,500 00
Boys' and Girls' Club Agents:				
Agent, Charlevoix County.....	600 00			600 00
Agent, Genesee County.....	600 00			600 00
Agent, Houghton County.....	600 00			600 00
Agent, Washtenaw County.....	600 00			600 00
Agent, Wayne County.....	600 00			600 00
Total.....	\$708,735 00	\$475,235 00	\$85,750 00	\$147,750 00
Vocational Teacher Training:				
Director.....	3,000 00		3,000 00	
Instructor.....	2,800 00		2,800 00	
Associate Professor.....	2,500 00		2,500 00	
Instructor.....	1,200 00		1,200 00	
Stenographer.....	1,200 00		1,200 00	
Stenographer.....	1,350 00		1,350 00	
Total.....	\$720,785 00	\$475,235 00	\$97,800 00	\$147,750 00

*House in addition.

†Rooms in addition.

TABLE NO. 11.—*Salaries Experiment Station, fiscal year ending June 30, 1920.*

Director.....	\$1,500 20
Assistant to Director and Live Stock Experimenter.....	2,547 80
Animal Pathologist.....	650 00
Bacteriologist.....	700 00
Research Associate in Bacteriology.....	2,433 90
Research Associate in Bacteriology.....	2,301 20
Research Associate in Bacteriology.....	1,499 90
Research Associate in Bacteriology.....	585 20
Research Associate in Bacteriology.....	1,018 10
Assistant in Bacteriology.....	197 80
Assistant in Bacteriology.....	400 00
Assistant in Bacteriology.....	2,001 10
Botanist.....	650 30
Research Associate in Plant Pathology.....	1,449 90
Research Assistant in Botany.....	1,122 50
Research Associate in Plant Physiology.....	1,750 15
Assistant in Plant Pathology.....	2,087 75
Assistant in Plant Pathology.....	375 00
Assistant in Plant Pathology.....	197 80
Chemist.....	3,550 75
Research Associate in Chemistry.....	2,733 90
Research Assistant in Chemistry.....	2,500 90
Assistant in Chemistry.....	1,532 20
Assistant in Chemistry.....	1,900 75
Assistant in Chemistry.....	1,367 35
Assistant in Chemistry.....	592 97
Assistant in Chemistry.....	1,667 60
Chief Inspector Fertilizer and Feeds.....	1,943 21
Inspector Fertilizer and Feeds.....	1,733 50
Inspector Fertilizer and Feeds.....	1,178 62
Inspector Fertilizer and Feeds.....	616 44
Associate Animal Husbandman.....	400 00
Dairy Husbandman.....	650 00
Assistant in Dairying.....	2,200 60
Assistant in Dairying.....	1,867 60
Assistant in Dairying.....	1,350 00
Assistant in Dairying.....	325 00
Field Accountant in Dairying.....	675 00
Field Accountant in Dairying.....	700 30
Entomologist.....	8 00
Research Associate in Entomology.....	2,000 00
Assistant in Entomology.....	400 00
Farm Crops Experimenter.....	700 00
Research Associate in Plant Pathology.....	1,919 95
Assistant in Farm Crops.....	500 00
Farm Crops Breeder.....	1,000 00
Assistant in Farm Crops.....	150 00
Assistant in Farm Crops.....	997 80
Assistant in Plant Breeding.....	117 90
Farm Mechanics Experimenter.....	228 70
Assistant in Farm Mechanics.....	584 20
Assistant in Farm Mechanics.....	787 50
Forestry Experimenter.....	450 00
Horticulturist.....	700 00
Research Assistant in Horticulture.....	300 00
Assistant in Horticulture.....	2,183 60
Poultry Husbandman.....	600 00
Assistant in Poultry.....	382 42
Assistant in Poultry.....	797 80
Soil Physicist.....	850 00
Research Associate in Soils.....	1,838 75
Research Associate in Soils.....	800 00
Research Assistant in Soils.....	1,046 00
Assistant in Soils.....	332 60
Assistant in Soils.....	350 05
Soil Investigator.....	900 00
Librarian.....	400 00
Secretary.....	700 00
Cashier.....	500 00
Bookkeeper.....	200 00
Stenographer.....	350 00
Stenographer.....	1,183 80
Bulletin Clerk.....	1,067 00
Total.....	\$79,133 36

AGRICULTURAL COLLEGE ACCOUNTS.

331

TABLE 12.—*Salaries Extension, fiscal year ending June 30, 1920.*

Administration:	
Director.....	\$3,550 55
Clerk.....	1,100 20
Supervisor Publications.....	1,100 00
Accountant.....	1,750 00
Stenographer.....	558 80
Stenographer.....	286 55
Stenographer.....	115 80
County Agents:	
State Leader.....	2,050 55
Assistant.....	1,500 60
Assistant.....	975 00
Assistant.....	1,178 10
Agent, Alger County.....	900 00
Agent, Allegan County.....	1,200 00
Agent, Alpena County.....	1,200 00
Agent, Antrim County.....	850 00
Agent, Baraga County.....	200 00
Agent, Barry County.....	1,203 30
Agent, Benzie County.....	1,200 00
Agent, Berrien County.....	1,150 55
Agent, Branch County.....	1,200 00
Agent, Calhoun County.....	1,200 00
Agent, Cass County.....	2,198 90
Agent, Charlevoix County.....	1,200 00
Agent, Cheboygan County.....	1,200 00
Agent, Chippewa County.....	1,200 00
Agent, Clinton County.....	953 85
Agent, Delta County.....	1,200 00
Agent, Dickinson County.....	1,337 77
Agent, Eaton County.....	1,036 91
Agent, Emmet County.....	1,200 00
Agent, Genesee County.....	1,200 00
Agent, Gladwin County.....	1,200 00
Agent, Gogebie County.....	1,200 00
Agent, Grand Traverse County.....	1,266 22
Agent, Houghton County.....	1,200 00
Agent, Iron County.....	1,200 00
Agent, Jackson County.....	600 00
Agent, Kalamazoo County.....	900 00
Agent, Kalkaska County.....	1,200 00
Agent, Kent County.....	1,200 00
Agent, Lapeer County.....	1,200 00
Agent, Lenawee County.....	900 00
Agent, Livingston County.....	1,200 00
Agent, Luce County.....	1,200 00
Agent, Macomb County.....	883 20
Agent, Manistee County.....	1,200 00
Agent, Marquette County.....	1,200 00
Agent, Mason County.....	631 10
Agent, Mecosta County.....	1,097 80
Agent, Menominee County.....	1,402 20
Agent, Missaukee County.....	1,200 00
Agent, Monroe County.....	1,651 95
Agent, Montcalm County.....	1,200 00
Agent, Montmorency County.....	702 20
Agent, Muskegon County.....	1,097 80
Agent, Newaygo County.....	401 10
Agent, Oakland County.....	1,200 00
Agent, Oceana County.....	202 20
Agent, Ogemaw County.....	1,200 00
Agent, Osceola County.....	797 80
Agent, Ottawa County.....	1,931 87
Agent, Otsego County.....	1,200 00
Agent, Presque Isle County.....	217 58
Agent, Saginaw County.....	835 35
Agent, Schoolcraft County.....	785 86
Agent, Shiawassee County.....	1,200 00
Agent, St. Clair County.....	1,200 00
Agent, St. Joseph County.....	1,097 80
Agent, Tuscola County.....	1,200 00
Agent, Van Buren County.....	1,200 00
Agent, Washtenaw County.....	1,200 00
Agent, Wayne County.....	1,650 01
Agent, Wexford County.....	993 80
Stenographer.....	891 30
Stenographer.....	1,075 15
Stenographer.....	

TABLE NO. 12.—*Con.*

Home Economics:	
Specialist in charge.....	\$1,934 10
Specialist.....	1,734 00
Specialist.....	1,734 00
Specialist.....	229 86
Stenographer.....	1,000 60
Extension Schools:	
Supervisor.....	2,067 60
Boys' and Girls' Club Work:	
State Leader.....	1,354 05
Assistant Leader.....	1,451 30
Assistant in Girls' Clubs.....	1,231 30
Assistant.....	1,667 00
Assistant.....	887 10
Assistant.....	1,767 00
Assistant.....	178 20
Agent, Alger County.....	325 00
Agent, Baraga County.....	300 00
Agent, Bay County.....	100 00
Agent, Berrien County.....	300 00
Agent, Branch County.....	400 00
Agent, Calhoun County.....	125 81
Agent, Chippewa County.....	50 00
Agent, Cheboygan County.....	524 77
Agent, Genesee County.....	600 00
Agent, Hillsdale County.....	300 00
Agent, Houghton County.....	599 50
Agent, Ingham County.....	300 00
Agent, Iron County.....	300 00
Agent, Jackson County.....	150 00
Agent, Kent County.....	249 50
Agent, Lenawee County.....	150 00
Agent, Osceola County.....	260 00
Agent, Saginaw County.....	348 73
Agent, Van Buren County.....	50 00
Agent, Washtenaw County.....	600 00
Agent, Wayne County.....	600 00
Stenographer.....	1,017 10
Home Demonstration Agents:	
Assistant Leader.....	2,267 00
Agent, Allegan County.....	1,000 00
Agent, Berrien County.....	250 00
Agent, Cass and Oakland Counties.....	789 76
Agent, Chippewa County.....	1,000 00
Agent, Dickinson County.....	1,000 00
Agent, Gogebic County.....	1,000 00
Agent, Houghton County.....	1,000 00
Agent, Kalamazoo County.....	1,000 00
Agent, Manistee County.....	783 00
Agent, Ottawa County.....	1,000 00
Agent, Schoolcraft County.....	1,000 00
Agent, St. Clair County.....	1,000 00
Agent, St. Joseph County.....	168 40
Agent, Wayne County.....	790 81
Stenographer.....	471 00
Farm Crops:	
Specialist.....	636 80
Specialist.....	1,462 60
Assistant Specialist.....	625 80
Assistant.....	850 48
Assistant.....	300 00
Agent.....	900 00
Stenographer.....	250 00
Live Stock:	
Specialist.....	1,067 00
Specialist.....	384 65
Horticulture:	
Specialist.....	1,716 89
Specialist.....	168 50
Potatoes and Vegetable:	
Specialist.....	2,667 10
Specialist.....	1,967 00

TABLE NO. 12.—*Concluded.*

Muck Crops:	
Specialist.....	\$2,017 00
Farm Management Demonstration:	
Specialist.....	682 10
Control of Insect Pests:	
Specialist.....	1,064 80
Specialist.....	1,377 00
Household Engineering and Drainage:	
Specialist.....	1,050 00
Forestry:	
Specialist.....	900 00
Dairy Products:	
Specialist.....	454 80
Markets:	
Specialist.....	700 00
Assistant.....	2,434 60
Assistant.....	1,234 60
Stenographer.....	882 15
Poultry:	
Specialist.....	1,201 12
Assistant.....	1,366 50
Soils:	
Specialist.....	1,000 00
Total.....	<u>\$155,684 06</u>

TABLE NO. 13.—*Income of the Michigan Agricultural College from all outside sources from the date of its foundation to the present time.*

Year.	From State Legislature		From U. S. Congress				Total
	For current expenses	For special purposes	Land sales, salt spring and swamp and grants, land grants.	Morrill act of 1862 interest from land grant and tree-pass	Hatch act of 1887, and Adams act of 1906, Experiment Station.	Morrill act of 1890, supply inventory endowment	
1855			\$56,320 00				\$56,320 00
1856							
1857	\$40,000 00						40,000 00
1858							
1859	37,500 00						37,500 00
1860							
1861	6,500 00		152 25				6,652 25
1862	10,000 00		248 97				10,248 97
1863	5,000 00		497 80				5,497 80
1864	9,000 00		726 00				9,726 00
1865	15,000 00		1,156 61				16,156 61
1866	15,000 00		1,004 27				16,004 27
1867	20,000 00		7,608 38				27,608 38
1868	20,000 00		592 49				20,592 49
1869	20,000 00	\$30,000 00	17,559 00	\$88 96			67,647 96
1870	20,000 00		1,320 02	2,720 93			24,040 95
1871	18,250 00	10,500 00	4,135 72	3,785 54			36,671 26
1872	18,750 00	3,000 00	217 05	7,175 65			29,142 70
1873	21,796 00	15,602 00	16 13	11,059 06			48,463 19
1874	13,000 00	15,602 00	150 13	11,061 98			42,814 11
1875	7,638 00	7,725 50	144 53	14,446 14			29,954 17
1876	7,638 00	6,755 50	1,773 00	19,830 17			35,996 76
1877	6,150 00	30,686 80	979 06	15,172 86			52,988 72
1878	6,150 00	3,686 80	826 60	15,807 04			28,470 49
1879	4,971 80	16,068 32	712 22	16,978 22			38,730 56
1880	4,971 80	7,068 32	707 55	17,837 24			30,674 91
1881	7,249 00	43,720 50	461 95	20,335 25			72,366 70
1882	7,249 00	8,945 50	358 46	22,207 45			39,060 41
1883	8,385 00	28,793 00	391 95	30,749 60			68,319 52
1884	8,385 00	10,526 00	1,259 90	27,309 72			48,080 62

AGRICULTURAL COLLEGE ACCOUNTS.

37

1887.	35, 103 00	187 50	29, 770 40			65, 040 90
1888.	22, 617 00		30, 461 04			53, 07 04
1889.	*44, 040 00	198 20	*24, 611 37			68, 849 57
1890.	30, 752 50	144 20	32, 406 60	\$	15, 000 00	78, 303 30
1891.	*20, 973 00	10 50	31, 322 69			67, 306 19
1892.						
1893.	*21, 172 00	238 50	32, 360 64	\$	15, 000 00	50, 171 14
1894.	22, 947 50	37 38	34, 750 34			67, 735 42
1895.	22, 947 50	137 38	34, 948 12			90, 033 00
1896.	18, 862 50	10 50	37, 927 04			89, 800 04
1897.	18, 862 50	433 59	44, 521 26			97, 823 35
1898.						
1899.	*19, 000 00	10 50	45, 301 82			99, 312 35
1900.	*16, 000 00		43, 886 40			95, 886 40
1901.	*17, 700 00		43, 179 54			98, 179 54
1902.	*17, 500 00		47, 508 28			103, 008 28
1903.	*17, 500 00	705 00	52, 526 11			100, 981 11
1904.	*17, 500 00					
1905.	*17, 500 00	175 00	72, 298 38			184, 973 38
1906.	*17, 500 00		63, 976 79			176, 476 79
1907.	*17, 500 00		64, 081 81			205, 081 81
1908.	*17, 500 00		65, 573 90			206, 573 90
1909.	*17, 500 00	61 19	67, 512 37			208, 373 56
1910.	*17, 500 00					
1911.	*17, 500 00		72, 035 32			293, 035 32
1912.	*17, 500 00		70, 286 56			283, 096 56
1913.	*17, 500 00		70, 135 22			293, 236 82
1914.	*17, 500 00		70, 385 79			298, 121 80
1915.	*17, 500 00		69, 524 13			301, 035 13
1916.	*17, 500 00					
1917.	*17, 500 00		71, 109 49			313, 519 49
1918.	*17, 500 00		70, 303 15			319, 714 15
1919.	*17, 500 00		70, 265 32			380, 065 32
1920.	*17, 500 00		70, 289 30			380, 089 30
Totals.	\$5, 921, 490 85	\$101, 723 66	\$2, 266, 165 54	\$686, 017 70	\$895, 000 00	\$11, 186, 818 08

*Including appropriation for weather service,
 †October 1, 1886 to June 30, 1887, nine months.
 ‡Including \$50.00 for institute and \$1,000 for weather service.
 §Including \$5,500 for institutes and \$1,000 for weather service.

‡Including \$2,750 for institutes and \$500 for weather service,
 †To June 30.
 ‡ Weather service.
 • Including \$5,500 for institutes and \$1,000 for weather service.

SUMMARY OF COLLEGE INVENTORY, JUNE 30, 1920.

Buildings and Lands:	
College Farm and Park, 671 acres.....	\$67,100 00
Athletic Field and Drive, 13 acres.....	1,300 00
Purchased C. D. Woodbury, 1916, 308.82 acres.....	38,602 50
Purchased 1913, 27 acres.....	3,375 00
Buildings:	
Library and Museum, built 1881.....	22,000 00
Wells Hall Rebuilt 1905-1906.....	55,000 00
Abbot Hall, Built 1888, Addition, 1896.....	15,000 00
Chemical Laboratory built in 1871, south end addition in 1881, east end addition, 1911.....	35,000 00
Veterinary Laboratory built 1885.....	5,000 00
Horticultural Laboratory built 1888.....	7,000 00
Entomological Laboratory built 1889, improved 1897.....	7,500 00
Botanical Laboratory built 1892, improvement 1909.....	20,000 00
Armory built 1885.....	6,000 00
Greenhouse and Stable built 1873, 1879, rebuilt 1892 and 1902.....	6,000 00
President's and two frame dwellings built 1874.....	12,000 00
Six brick dwellings built 1857, '79 and '84.....	18,000 00
One frame house built 1885.....	3,500 00
One frame house.....	2,500 00
Howard Terrace dwelling built 1888.....	13,000 00
Farm house dwelling built 1869.....	2,000 00
Herdsmen's dwelling built 1867.....	400 00
Horticultural barn and shed built 1868, 1875, 1877.....	1,200 00
Bull Barn rebuilt 1905.....	1,500 00
Sheep barn rebuilt 1906.....	2,500 00
Horse barn built 1906.....	5,000 00
Grade herd barn rebuilt 1905.....	4,000 00
Piggery rebuilt 1907.....	1,500 00
Dairy barn rebuilt 1900.....	4,000 00
Farm Mechanics Building built 1881.....	1,500 00
Poultry house built 1906.....	1,000 00
Incubator house built 1906.....	500 00
Poultry house built 1907.....	1,500 00
Three poultry houses built 1907.....	300 00
Ten brooder houses built 1908.....	250 00
Corn barn built 1878.....	400 00
Stable built 1894.....	200 00
Brick work shop built 1857.....	500 00
Observatory built 1880.....	100 00
Bath house and fittings built 1902-3.....	17,000 00
Hospital.....	3,000 00
Waiting room and bookstore built 1902.....	1,700 00
One silo.....	200 00
Womens Building built 1909.....	91,000 00
Forestry Building built 1900.....	15,000 00
Bacteriological Building built 1902.....	27,000 00
Power house built 1904.....	25,000 00
Tunnel system built 1904.....	45,000 00
Cold storage rebuilt 1905.....	2,000 00
Iron bridge over Cedar River built 1888.....	1,500 00
Bridge to Athletic Field.....	500 00
Manure shed.....	600 00
Four hospital cottages built 1909.....	6,000 00
Agricultural Building built 1909.....	182,000 00
Tile silo No. 1.....	500 00
Piggery for serum production.....	1,000 00
Two tenant dwellings built 1912.....	2,400 00
New dairy building built 1913.....	55,000 00
Tile silo No. 2.....	600 00
Tile silo No. 3.....	600 00
Two stave cement silos.....	800 00
Forestry packing house.....	1,000 00
Veterinary Laboratory built 1914.....	33,000 00
Special Chemical Laboratory.....	800 00
R. E. Olds Hall of Engineering built 1916.....	155,000 00
Shop No. 1 built 1916.....	26,400 00
Shop No. 2 built 1916.....	15,750 00
Shop No. 3 built 1916.....	14,500 00
Gymnasium built 1916.....	220,000 00

\$1,311,077 50

SUMMARY OF COLLEGE INVENTORY.—*Concluded.*

Amount Forwarded	\$1,311,077 50
Division of Agriculture:	
Department of Agricultural Education.....	\$727 88
Department of Animal Husbandry.....	30,308 21
Department of Dairy Husbandry.....	35,549 64
Office of Dean of Agriculture.....	1,058 15
Department of Farm Crops.....	2,973 72
Department of Farm and Horses.....	24,113 12
Department of Farm Mechanics.....	13,178 37
Department of Forestry.....	13,473 35
Department of Horticulture.....	4,326 95
Department of Poultry Husbandry.....	12,332 78
Department of Soils.....	9,462 83
Division of Engineering:	
Department of Civil Engineering.....	17,954 55
Office of Dean of Engineering.....	2,852 08
Department of Drawing and Design.....	8,414 86
Department of Electrical Engineering.....	19,037 72
Department of Mechanical Engineering.....	83,212 99
Division of Extension.....	13,325 78
Division of Home Economics:	
Dean of Women.....	18,494 00
Department of Domestic Art.....	4,659 29
Department of Domestic Science.....	7,710 91
Division of Science and Letters:	
Department of Bacteriology.....	17,451 99
Department of Botany.....	25,279 38
Department of Chemistry.....	66,101 32
Department of Economics.....	250 50
Department of English.....	1,462 19
Department of Entomology.....	10,618 88
Department of History.....	648 75
Department of Mathematics.....	807 45
Department of Meteorology.....	329 09
Department of Military Science.....	2,522 00
Department of Music.....	3,501 00
Department of Physical Training.....	14,427 86
Department of Physics.....	11,317 50
Department of Zoology and Physiology.....	17,145 77
Division of Veterinary Science:	
Department of Anatomy.....	17,184 10
Department of Animal Pathology.....	6,459 07
Department of Surgery and Clinic.....	4,252 27
Department of Veterinary Medicine.....	5,436 77
Miscellaneous:	
Abortion barn.....	1,493 35
Alumni Recorder's Office.....	487 17
Carpenter Shop.....	6,799 01
Cleaning.....	1,254 73
Hospitals.....	3,737 90
Library.....	79,556 33
Michigan Weather Service.....	845 00
Orchard and Nursery Inspection.....	1,212 05
Paint Shop.....	4,298 66
Post Office.....	1,383 21
President's Office.....	637 00
Registrar's Office.....	1,244 28
Secretary's Office.....	10,113 97
Seed Laboratory.....	961 39
Soil House.....	745 45
Sundry.....	6,137 00
Vocational Teacher Training.....	628 03
Water, Heat and Light.....	49,552 58
Wells Hall.....	2,476 26
Total	\$2,013,003 94

SUMMARY OF EXPERIMENT STATION INVENTORY.

Division of Experiment Station:	
Buildings.....	\$34,075 00
Lands.....	33,000 00
Section of Bacteriology.....	11,511 87
Section of Botany.....	8,137 50
Bulletin Room.....	2,584 50
Section of Chemistry.....	14,548 96
Office of the Director.....	650 22
Section of Entomology.....	8,009 62
Section of Farm Crops.....	2,266 30
Section of Graham Hort. Experiment Station.....	22,447 25
Section of Horticulture.....	2,287 60
Library.....	7,562 95
Section of Soils.....	6,973 56
Section of South Haven Experiment Station.....	893 35
Section of Upper Peninsula Experiment Station.....	17,869 70
Total.....	\$172,818 38
Total of College Inventory.....	2,013,003 94
Total of Experiment Station Inventory.....	172,818 38
Grand Total.....	\$2,185,822 32

REPORT OF THE DEAN OF AGRICULTURE.

To President F. S. Kedzie:

This year witnessed a more complete return to normal conditions following the disturbances in agricultural educational work resulting from the war. In view of the fact that the influences of war conditions tended to divert the minds of young men toward lines other than agriculture, the freshmen enrollment of 210 was considered to be very gratifying indeed. The graduating class of 132 contained a large number who returned to complete the course after having dropped out at some time during the war period. The graduate school was reestablished during the year and is again progressing on a very satisfactory basis. The institution is well equipped to extend this line of work which deserves the support of the institution as a whole. My own participation in instruction work consisted in presenting the subject of farm management to short course men and juniors and the subject of agricultural development to freshmen.

The following statistics present a classified statement of the enrollment within the division during the year:

Advanced Degree.....	7
Graduating Class	132
Graduate Students	10
Seniors	115
Juniors	90
Sophomores	117
Freshmen	210
Specials	23
Summer Session	143

847

SHORT COURSE.

Two Year Sixteen Weeks' Course, First Year....	118
Two Year Sixteen Weeks' Course, Second Year....	50
General Agriculture, Eight Weeks, First Year....	89
General Agriculture, Eight Weeks, Second Year...	31
Horticulture, Eight Weeks	18
Poultry, Four Weeks	15
Dairying, Eight Weeks	18
Gardening, Two Weeks	9
Beekeeping Course, Two Weeks	13
Cow Testing and Dairy Barn Management, Two Weeks	30
Experienced Creamery Men's Course, One Week...	13
Ice Cream Makers' Course, Two Weeks.....	13
First Truck and Tractor Course, Four Weeks.....	72
Second Truck and Tractor Course, Four Weeks...	88

577

1424

Numerous meetings of farmers and stockmen were held in close association with the division during the year. Most notable among these were the State Live Stock Breeders' Association, the various breed organizations, the Farmers' Week, Crop Improvement Association, in addition to several conferences relating to agricultural education and extension, including such special features as organization, marketing, etc.

The division assisted several state breeders organizations to conduct pure bred stock auction sales at the institution during the year. These privileges are extended only to breed association organizations. These sales bring to the institution many people who have not previously come in contact with it, thus adding material support. In order to properly house consignments of live stock and provide more suitable sale conditions the construction of a sale and stock judging pavilion should be undertaken as soon as possible. These needs suggest an elliptical structure not less than 60x120 feet with seating for at least three thousand people, the structure to be placed adjacent to the east end of the present stock judging pavilion.

Owing to the unsuitable location of the piggery, the division is desirous of establishing a new plant in field number seven, just across the farm lane bridge on the east side. This will mean the apportionment of sufficient funds to construct a complete new set of buildings, feeding floors and yard and field fences. There is nothing of value in the present equipment worth removing. It is our earnest wish that funds may be provided at an early date to accomplish these plans.

We feel called upon to direct especial attention to the needs of the Horticultural department by way of both suitable commercial and experimental greenhouses as well as adequate laboratory facilities. The enormity and importance of the horticultural interests of the State demand provision for these needs at an early date.

Owing to the intimate relationship of mechanics to the present day agricultural practice, there is a pressing need for more facilities for the Farm Mechanics department. There is also a need for an extension of courses now offered as well as the addition of some new ones.

It is hoped that the Farm Management department established within the division by the State Board may soon be equipped with a strong staff to carry on the educational and investigational work so much needed.

The details of work of the departments of the various divisions is given elsewhere by the various heads. The work of the year has been harmonious and effective and we greatly appreciate the hearty support given our office by all members of the division staff. We record with regret the resignation of Professor A. C. Anderson, which took effect July 1st, after many years of arduous and faithful service, which resulted in building up a large, effective department in addition to greatly stimulating the dairy industry of the State.

Respectfully submitted,

R. S. SHAW,

Dean of Agriculture.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF HORTICULTURE.

To President F. S. Kedzie:

Dear Sir:—

The work of the department the past year has been very strenuous, although quite satisfactory, as it has been concerned largely with conditions characteristic of a period of readjustment and development.

It was very encouraging to note at the beginning of the school year that such a large number of young men, who had formerly dropped their studies to give their services to their country in the war, returned to complete their college course. Considering the remunerative wages being offered at the time, this demonstrated their foresight and appreciation of the education and training they were obtaining at this institution. These young men exhibited a seriousness and earnestness in their work that made it very pleasing to be associated with them, and I am very happy to say that at the time of graduation the demand for these young graduates in horticulture exceeded the supply. The number of students enrolled in the regular collegiate work exceeded in number any of the classes since the beginning of the war as may be seen by the brief summary as presented in the following table:

FALL TERM.

Class.	Subject.	No. of Course.	Hours per week each Student.	Number Students Enrolled.
Sophomore Ag.	Fruit Growing.	2	4	159
Junior Ag.	Pomology.	4	7	28
Senior Ag.	Plant Breeding.	7	7	31
Senior Ag.	Seminar.	10a	1	27
Senior Ag.	Advanced Pomology.	11a	6	27
Senior Ag.	Advanced Landscape Gardening	12a	6	1
Junior and Senior Home Economics	Landscape Gardening and Floriculture	14	7	15

WINTER TERM.

Class.	Subject.	No. of Course.	Hours per week each Student.	Number Students Enrolled.
Sophomore Ag.	Plant Propagation	3	4	101
Junior Ag.	Greenhouse Industry	5	7	25
Senior Ag.	Commercial Horticulture	8	5	23
Senior Ag.	Seminar	10b	1	27
Senior Ag.	Advanced Pomology	11b	6	23
Senior Ag.	Advanced Landscape Gardening	12b	6	6

SPRING TERM.

Class.	Subject.	No. of Course.	Hours per week each Student.	Number Students Enrolled.
Junior Ag	Landscape Gardening	6	7	25
Senior Ag	Horticultural Practice	9	10	21
Senior Ag	Seminar	10c	1	27
Senior Ag	Advanced Pomology	11c	6	23
Senior Ag	Advanced Landscape Gardening	12c	6	3

In addition to these regular courses, instruction was given during the summer school in Plant Propagation and Fruit Growing to eighteen students, 15 hours per week.

The short courses in horticulture were also well attended considering the labor situation existing at the time on the farms.

The special eight-weeks course in Fruit Growing was attended by eighteen students and it is interesting to note that at least half of these students came from fruit farms in the fruit sections where they had had the practical experience of raising fruit and came here to obtain information and training on the more scientific phases of their work.

A very satisfactory line of work that it has been our pleasure to perform this year has been that of teaching the "Federal Aid" students. While there is less uniformity in the previous school training of these students, their earnestness in the work and the satisfaction of being able to render them aid in preparing them for productive lines of work is an incentive that is very gratifying. The department gladly offers its resources to the education of the "Federal Aid" students.

A few important changes in the course of study in horticulture were made during the school year. The subject matter previously presented in the fall and winter terms in Plant Breeding and Evolution was combined into one five-credit course of the fall term and a new course in Commercial Horticulture presented in the winter term. This course was much needed and proved very satisfactory.

The students in Landscape Gardening were offered ten credits of landscape work each term whereas formerly the landscape students had but five credits of landscape gardening each term and were obliged to take the work with the pomologists in Plant Breeding and Evolution. Even this amount of time for specialization in landscape gardening is insufficient to give a student the amount of training that should be received to be properly prepared for landscape practice. It is the opinion of the writer that specialization in horticulture should begin at least by the first term of the junior year.

There are two important lines of horticultural practice in Michigan in which this department does not offer instruction. The increasing economic importance in the State of vegetable gardening and floriculture makes it advisable that this department develop courses to meet the demand in these lines. Very little can be done in either of these lines until facilities are provided in the form of a new greenhouse system and a horticultural building in which to offer this instruction. The writer knows that these will be forthcoming as soon as the funds are available and the present abnormal cost of construction subsides.

The department also appreciates the desirability of presenting a course

in horticultural products. Such a course would aim to give some training in commercial canning, preserving, dehydrating and otherwise utilizing orchard and garden products. Michigan now has about eighty canning factories and many cooperative fruit associations that in the near future will be operating orchard products factories. Higher prices of labor and otherwise increased cost of production makes it of greater importance than ever to conserve the vast waste that has occurred in the marketing of these products. This institution must continue to take the lead in the great educational work of economic horticulture. A course in horticultural products is needed for this purpose.

During the fall our Extension Specialist, Mr. I. T. Pickford, was temporarily engaged as instructor in horticulture to supplement our teaching force and did very creditable work. Mr. R. R. Jeffries was engaged January first as an Assistant Professor of Horticulture. Mr. Jeffries proved a very able and enthusiastic teacher but, we are sorry to state, leaves us on July 1st to accept a position in a more remunerative line of work. During the winter term, Mr. Robert M. Lautner was engaged to assist in teaching the short course classes.

It is a pleasure to report that as in the past Ass't Professors Gunson and Loree, Extension Specialists I. T. Pickford, C. W. Waid, H. C. Moore, and Miss Mary Rozema have each rendered very efficient service. The writer wishes to express his appreciation for their cooperation in the work of the department.

Very respectfully submitted,

C. P. HALLIGAN,

Professor of Horticulture.

East Lansing, Mich., June 30th, 1920.

REPORT OF THE DEPARTMENT OF DAIRY HUSBANDRY.

To the President of the Michigan Agricultural College.

Sir: The report of this department for the year ending June 30, 1920, is submitted herewith. It may be said that the Dairy department worked throughout the year handicapped by the small size of the teaching and investigational staff. This condition was brought about by the fact that during the war no additions were made to the teaching staff, nor were the positions of the men entering the service filled until they returned. In addition to this condition the demands upon the department for information and services not usually considered in routine of college work, such as attendance at meetings of dairy farmers, dairy manufacturers, and consumers, have been unusually heavy.

DEPARTMENTAL STAFF.

The personnel of the department has been as follows:

*A. C. Anderson, Professor of Dairy Husbandry.

O. T. Goodwin, Associate Professor of Dairy Husbandry.

J. E. Burnett, Assistant Professor of Dairy Husbandry.

F. T. Riddell, Investigator in Dairy Production.

Stanley J. Brownell, Investigator in Market Milk Distribution.

**R. W. Wyant, Instructor in Dairy Husbandry.

***Hilda Kellner, Instructor in Dairy Husbandry.

INVESTIGATION.

Mr. F. T. Riddell has continued investigations in the cost of milk production. In this work he has been assisted by two field agents. In co-operation with Professor Anderson, Mr. Riddell has published a bulletin, *Cost of Milk Production No. 2*.

Mr. Stanley J. Brownell has concluded studies of the distribution of milk in Lansing and Kalamazoo and is at present doing similar work in the city of Flint. It is expected that the results of these studies will appear in bulletin form during the coming year.

Preliminary work was done by the writer with Mr. H. W. Norton, Jr., on an experiment to determine the feeding value of sunflower silage. This work showed evidence of need of further study and a more conclusive experiment is planned for the future. The writer also started a trial of a self feeder for dairy calves to determine if possible the practicability of such a feeding method.

EXTENSION SERVICE.

Mr. J. A. Waldron of the Extension division has continued to serve as Extension Specialist in Dairying. Mr. Waldron's work has been entirely along the line of dairy production. Mr. O. T. Goodwin was employed as Extension Specialist in Dairy Manufactures until Sept. 1, 1919, when he became Associate Professor of Dairy Manufactures. Since Sept. 1st the position of Extension Specialist in Dairy Manufactures has been unfilled.

ADVANCED REGISTRY TESTING.

Up to March 1, 1920, this work was carried on by the writer. At that time Mr. Elmer B. Hint was appointed as Superintendent of Official Testing and has since carried on this work of great financial im-

* It is to be noted with deep regret that Prof. A. C. Anderson severed his connection with this department July 1, 1920. The loss of Prof. Anderson's services is keenly felt by every member of the staff and deeply regretted by the dairymen of the State. Prof. Anderson, beginning his work in 1908, built the Dairy department from a division of the Agricultural department to its present size. During this time his services to the State have been manifold, but his outstanding work of recent years has been the development of the cost of milk production investigation. In the past year the results obtained by this work have been used as a basis for determining a fair price for milk to the producer and to the consumer about the State.

** Mr. R. W. Wyant completed his work for a Master's degree in March, 1920, and was reappointed on the staff April 1, 1920, as Instructor in Dairy Husbandry. Mr. Wyant's work has been with the handling of market milk.

*** Miss Kellner was appointed January 1, 1920. Miss Kellner has had charge of the instruction in and the manufacture of cheese.

portance to the breeders of pure bred dairy cattle in Michigan. It is pleasing to note that in spite of war conditions the number of official seven day tests conducted in the State has increased 17.8 per cent during the last five years. It is also a matter of satisfaction to find that the amount of butter fat produced by Michigan cows, as shown by these seven day tests, has increased from an average of 15.35 pounds of fat in 1908 to 18.41 pounds in the year ending June 30, 1920. This is an increase of 20.3 per cent. Undoubtedly this increase is due to better knowledge of breeding and feeding obtained through these tests.

The semi-official or yearly testing has also increased markedly in the past year. During the year ending June 30, 1919, there were 250 cows on test in the three leading breeds in the State, Jersey, Guernsey and Holstein-Friesian. During the year ending June 30, 1920, there were 437 cows tested in these same three breeds, an increase of 61.4 percent.

If it had been possible to secure more help on the farms and more men to act as supervisors, the increase in both divisions of this work would have been greater.

DAIRY BARN.

As noted above some experimental work was carried on at the dairy barn. Other notable events during the year was the development of Bravura 3d, a Brown Swiss cow that produced 12,918.4 pounds of milk containing 558.441 pounds of butter fat, thereby breaking the world's record for breed and age. College Belle Butter Lass, a Holstein-Friesian cow, produced 25,079.2 pounds of milk containing 1112.65 pounds of 80 percent butter in a yearly test. This cow was later sold for \$3,250.00 at public auction.

Respectfully submitted,

J. E. BURNETT,

Assistant Professor of Dairy Husbandry.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE DEPARTMENT OF FARM CROPS.

President F. S. Kedzie, M. A. C.

Dear President Kedzie:—During the past year, particular effort was made by the instructional staff of the Farm Crops department to increase the efficiency of the teaching work. Two new courses were added—Farm Crops 6-Crop Adaptation and Experimental Methods, and Farm Crops 4-B-Advanced Genetics. The elementary Forage Crops course (Farm Crops 2) was given, for the first time, as a combined laboratory and lecture course. Advanced work in grain standardization was given as part of courses 5 and 6, and a full equipment of grain standardization apparatus was installed. The use of crops samples in laboratory work was increased, and the material used for instructional and display purposes was considerably augmented.

The fall and spring crops courses were supported by more frequent field trips than previously. Carefully prepared lantern-slide lectures have

been developed for each course given. The instructional work in Crops is based largely on lectures and in addition, much use is made of crops specimens, crops experiments and variety increases growing in the fields, short field trips, and lantern slides, showing crop production methods and cultural conditions found throughout the State.

The following courses were presented by the department:

Farm Crops I, Cereals, 226 students.

J. F. Cox and Assistants.

Farm Crops II, Forage Crops, 172 students.

C. R. Megee.

Farm Crops III, Special Michigan Crops and Advanced Cereals, 56 students.

A. L. Bibbins, J. R. Duncan and Assistants.

Farm Crops IV, Special Michigan Crops and Advanced Forage Crops, 52 students.

J. F. Cox.

Farm Crops V-A, Genetics, 5 students.

F. A. Spragg and E. E. Down.

Farm Crops VI A, Crops Adaptation. B, Experimental Methods. C, Grain Standardization, 62 students.

J. F. Cox, A. L. Bibbins, C. R. Megee and G. W. Putnam.

Plant Breeding, Graduate Students, 2.

Crop Ecology, Graduate Students, 1.

Short Course

Eight weeks, first year, S. C. Winter, 1920, 90 students.

Eight weeks, second year, S. C. Winter, 1920, 33 students.

Sixteen weeks, second year, S. C. Fall, 1919, 27 students.

Summer School, 1920

Farm Crops 3, Summer, 1920, 19 students.

Farm Crops 2, Summer, 1920, 14 students.

C. R. McGee and J. R. Duncan.

The members of the Department of Farm Crops appreciate the sound support which has been given them, which has made possible substantial development in certain lines of our instructional work.

Respectfully submitted,

J. F. COX,

Professor of Farm Crops.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE DEPARTMENT OF SOILS.

President Kedzie:

There are certain changes and additions to our soils courses that could be brought about with great benefit to the students. A five hour elective course for students of Animal Husbandry and for Horticultural students should be offered.

Although there is much progress to be made in extension work in Soils the results obtained by the various members of the section are gratifying. I do not consider that this line receives the financial support that its relative importance and the demands for it by the farmers of the State justify. An additional assistant extension and experiment station worker should be engaged. This is so because the field projects have been so developed that a leader should be responsible for and confine his efforts to one of three proposed divisions of the State.

The Soils department is badly in need of storage room for fertilizers, soils and seed. The present arrangement is not only inadequate but also very inconvenient and unsatisfactory. Much time and energy are wasted in transferring these materials from one place to another.

Our instructional work for seniors will never be complete and of maximum efficiency until adequate greenhouse facilities are provided. Moreover several of our experimental and research projects call for such.

Again I desire to commend to you the splendid cooperative spirit and enthusiasm of the various members of the staff. Each of us appreciates the interest you have taken in our endeavors and the support you have afforded us.

Respectfully submitted,

M. M. McCOOL,

Professor of Soils.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY

Pres. F. S. Kedzie.

Dear Sir.—I have the honor to submit the following report of the Department of Animal Husbandry for the year ending June 30, 1920.

Instruction was carried out as prescribed in the catalogue. The enrollment in the various classes and the hours of teaching work per week were as outlined in the following table:

Subject.	Sect.	Days per week.	Lect. Hrs. per week.	Lab. Hrs. per week.	Total Hrs. per week.	No. in Class.	Totals.
Fall Term:							
Regulars:							
A. H. 1	1-4	3	3	3	6	59	102
Above class divided for Lab.							
A. H. 1	5-8	3	3	3	6	60	126
Above class divided for Lab.							
A. H. 2		3	3	3	6	33	67
Above class divided for Lab.							
A. H. 5		5	2	4	4	26	
Short Course:				6	8	52	
A. H. 1		5	5	5	5	60	
				5	10	129	
Above class divided for Lab.							
A. H. 4		5	5		5	120	5816
Winter Term:							159
Regular:							
A. H. 4		5	5	5	19	68	
A. H. 6	1	5	2	6	8	23	
A. H. 6	2	5	2	6	8	19	
Short Course:							
Types and Breeds				4	4	45	
Breeds		4	4	4	8	90	
				5	5	60	
		5	5	5	10	121	
Feeding	1	5	5	5	5	49	
Feeding	2	5	5	5	5	42	
Judging	16 week men	3		6	6	20	
Judging	8 week men	2		6	6	27	
Live Stock Management		5	3	3	6	18	
Spring Term:							572
A. H. 7		5	3	4	7	46	181

*No. in class. †Hours per week.

During the fall and winter terms, we were fortunate in having the assistance of Mr. Donald Williams, who, with Mr. Edwards and the writer, handled the above class work. You will note that during the fall term we had an enrollment of 816 men in eleven classes, or about seventy-five men per class, and that each member of the department had twenty hours of teaching work per week. In the winter term, we had an enrollment of 572 men in eleven classes, or fifty students in each class, and approximately twenty-four hours of teaching per week for each member of the department.

Mr. Williams joined the Extension staff March first, leaving Mr. Edwards and myself to handle the work for the coming year.

Aside from teaching, the department has a large amount of live stock equipment to manage, a large number of inquiries for information, requests to attend meetings throughout the State, and in addition are expected to conduct experimental work. With the present personnel, it is extremely difficult to handle the teaching work as it should be done to say nothing of the other activities in which the department should be engaged. If the department is to fulfill its duty to the students and to our constituents throughout the State, not less than two men should be added to the personnel for the coming school year.

Very little change has been made in the live stock equipment during the past three years, the apportionment being only sufficient to defray the necessary expense of maintenance, leaving no funds to purchase better breeding animals for the herds and flocks. I would earnestly request that a separate fund be set aside each year for the purchase of additional breeding animals with which to improve our herds and flocks.

Yours respectfully,

GEO. A. BROWN,

Professor of Animal Husbandry.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE DEPARTMENT OF POULTRY HUSBANDRY.

President F. S. Kedzie, College.

Dear Sir: I have the honor to submit the following report of the Department of Poultry Husbandry for the year ending June 30, 1920.

We are occupying twenty buildings; 1 house 18 feet x 184 feet, one house 16 feet x 84 feet, 3 houses 16 feet x 24 feet, 1 house 16 feet x 84 feet, 1 Granary 18 feet x 30 feet, 1 house 20 feet x 20 feet, 1 house 14 feet x 28 feet, one house 18 feet x 20 feet and ten colony houses 10 feet x 12 feet. One new house for experimental purposes has been built during the year that has incorporated in it the latest ideas of lighting and ventilation. The ten colony houses for range work have been built during the year and are as nearly as possible made thief proof.

EQUIPMENT.

The department has full capacity to hatch and to brood 5700 chicks at one hatch or an increase of 1000 chicks over last year.

Breeds of fowls that are common to the farms of Michigan are kept. Besides the more common breeds of fowls a large number is kept for classroom work.

EDUCATIONAL.

A complete system of pedigreeing has been developed during the year. Breed tests for farmers and breeders have been offered.

The problem of higher fecundity has been carried forward which will take the form of Registry of Merit next year. By this is meant, that the poultry department will encourage farmers and breeders of poultry to send representatives of their flocks to the College for official trap nesting for a year. The better specimens will go back to the State as foundation stock for future breeding of a better quality of productive stock.

INSTRUCTION.

Besides the regular college courses there have been given four short courses of a general nature. One was given during the summer of 1919. Three were given in January and February. The total enrollment of students for the short courses was 273 for the year.

EXTENSION.

A large amount of work has been done in the State in culling fowls for egg production. About forty demonstration farms have been supervised and demonstrations given on same. Women's poultry clubs have been formed. The Extension Service has cooperated with County Agents and Home Demonstration Agents of the State. Two Extension Specialists have been maintained during the year.

Respectfully submitted,

C. H. BURGESS,

Professor of Poultry Husbandry.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF FARM MECHANICS.

Pres. F. S. Kedzie,
East Lansing, Michigan.

Dear Sir: At the request of Prof. Musselman, I have the honor to submit the following report of the Farm Mechanics department for the year ending June 30, 1920.

Prof. Musselman had charge of the department from July 1 until December, 1919, when he was granted a leave of absence to take up army vocational work at Camp Grant. Since the latter date, I have had charge as Acting Head.

INSTRUCTION.

During the year, two additional men have been added to the staff. Mr. E. C. Sanve, who began work October 14, 1919, as Assistant Professor, has charge of the instruction work in Power and Farm Machinery. Mr. Floyd E. Fogle, who began work December 1, 1919, has had charge of the instruction work in Farm Buildings and Home Conveniences.

The personnel of the entire staff has changed during the year. Mr. Duncan, our former instructor in forge work, resigned and was replaced by Mr. D. L. Shafer. Mr. Jesse Bowers had charge of the wood shop and Mr. D. A. Taylor now has charge of the laboratory equipment, replacing Mr. Toms who resigned last year. In addition to the regular staff, twelve instructors were employed at various times to assist in short course work. A great deal of credit is due the members of the staff and the temporary instructors for their enthusiasm and hearty cooperation in the work.

During the year, 162 regulars and 960 short course students, a total of 1122, were given instruction in the various courses, distributed as follows:

Number of students taking work in various courses:

REGULARS.

Power Machinery.....	64
Summer School.....	20
Farm Machinery.....	12
Farm Structures.....	22
Farm Conveniences.....	12
Drainage	11
Federal	5
Summer Federal.....	9

162

SHORT COURSE.

Farm Conveniences	23
Building Design.....	142
Power Machinery.....	64
Wood Work.....	189
Forge Work.....	199
Creamery Mechanics.....	14
Truck and Tractor, First course.....	60
Second course.....	142
Drainage	7
Drainage and Concrete.....	140

980

Total 1142

EXPERIMENT STATION.

Mr. Sauve and Mr. Fogle are spending part of their time in experimental work, the former in securing data on the cost of operating tractors and other power machinery. Mr. Fogle has been spending considerable time in securing data on farm building construction.

EXTENSION.

The extension work in Drainage has been very efficiently handled by Mr. Walter Van Haitsma since January 1, 1920. Mr. Van Haitsma had charge of the tile drainage demonstrating machine in St. Clair county during the summer of 1919. The demonstration plots put in at that time together with the demonstration meetings held have created a great deal of interest in drainage work in that county.

Respectfully yours,

O. E. ROBEY,

Acting Professor of Farm Mechanics.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF FORESTRY.

The President, Michigan Agricultural College.

Sir: I have the honor to submit the following report for the Department of Forestry for the year ending June 30, 1920.

The work of instruction was carried on during the year as described in the college catalog. Mr. Phillip L. Buttrick was appointed Assistant Professor of Forestry on March 25. Professor Sanford was granted leave of absence for six months beginning April 1. The teaching work for the year was as follows:

	Number of Classes	Number of Students
A. K. Chittenden.....	11	274
F. H. Sanford.....	5 (Two terms)	69
P. L. Buttrick.....	3 (One term)	44

The forest nursery was operated as usual, planting stock amounting to 130,060 trees having been shipped during the year. Interest in forest planting has increased greatly since the war. The highway planting bill which was passed at the last session of the Legislature authorizes the College to raise trees for highway planting in the State and we are, therefore, extending the scope of the nursery with the view of raising larger deciduous trees than heretofore, for this purpose. Tree seed has been very difficult to secure during the last few years and it will be some time before we have many trees suitable for highway planting. The section of the nursery devoted to foreign trees was added to very materially during the year. We now have many trees from China, Russia and other countries which have been given to the College by the United States Department of Agriculture. This feature of the nursery promises to be of increasing interest as time goes on.

The sugar bush in the woodlot was operated as usual, the season, however, being a very poor one. Thinnings were made in the woodlots and considerable cord wood sold during the year.

The third annual meeting of the Michigan Maple Syrup Makers' Association was held in the College during Farmers' Week and was well attended. Owing to the resignation on December 31, of Mr. E. C. Mandenberg, Extension Specialist in Forestry, it has not been possible for us to meet the calls for assistance in forestry matters in the field to the extent that seems desirable. I hope that it will soon be possible to again fill this position.

With an increasing number of students, the department has need of more laboratory space. At the present time much of our equipment cannot be used to the best advantage for lack of room, and the students are unduly crowded in the laboratories.

I wish to express my appreciation of your suggestions and encouragement during the year.

Respectfully submitted,

A. K. CHITTENDEN,

Professor of Forestry.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF AGRICULTURAL EDUCATION.

To the President and Members of the State Board of Agriculture:

Gentlemen: I have the honor to submit the following annual report of the Department of Teacher Training for the current year.

(a) Courses in Education for Women. During the college year we have enrolled from the junior and senior classes, 111 women, and of this number 61 were graduated with the degree of Bachelor of Science and having pursued the required courses in Education, they were granted State teachers licenses. Of the total number, fifty (50) had taken the special educational work for Home Economics and Practice Teaching and were, therefore, granted a special teachers license, authorizing them to teach Home Economics in Smith-Hughes schools. These latter certificates were granted by the Superintendent of Public Instruction, and I may say that all of these young women except five (5) who declined to teach, have secured positions for next year.

(b) Education for Men. The current college year has been rather unsettled in the various college courses on account of men returning from military service. In the special courses in Education, we have enrolled seventy-two (72) juniors and seniors, and of this number, fifty-seven (57) senior students in Agriculture, have pursued the special courses in Education, together with the regular courses in Agriculture, thus qualifying them as teachers of Agriculture in Smith-Hughes schools, and they have been granted teachers licenses accordingly. Of this number, twenty-three (23) have been employed as teachers of Agriculture for the ensuing year. One goes to the University of Michigan as a post-

graduate student, having a scholarship issued by that institution. Several have been employed as County Agricultural Agents, and others have returned directly to the farm.

(c) Practice School. Our plan of giving to the senior students practice teaching was explained to the Board in our last report. We make use of the students in the East Lansing High School for practice classes in agriculture and home economics. It is required that each college student shall have six (6) weeks or more of practice teaching. We have used about sixty (60) students from the high school for this work.

Mr. E. L. Grover is in charge of the practice teaching, and has shown himself an educational expert. The men who go out to teach agriculture, show by their grasp of the situation and their skill of procedure that the practice school is both efficient and effective.

Miss Elizabeth Frazer is in charge of the practice teaching for women and is equally efficient in her department. It appears at the same time, that we have been able to train a sufficient number of teachers in agriculture and home economics to supply these special schools in the State.

In Michigan, we have for the current year, agricultural departments in fifty-nine (59) schools and for the ensuing year, we expect to have sixty-seven.

There are 125 high schools in the State having departments of home economics and of this number sixty-three (63) are taught by graduates of this institution. There are 15 of these high schools teaching home economics under the provision of the Smith-Hughes law.

(d) Teacher Training. As director of Teacher Training, I have given the instruction in educational subjects to both men and women, and have supervised the work in the Practice School. I also communicate with the superintendents of the schools of the State in regard to departments of agriculture and home economics, and assist said superintendents in the location of teachers who have been trained in this institution. In fact, we operate practically a teachers location bureau without expense to the students; and as stated above, we have located all the men available for teaching agriculture, and all the women for teaching home economics.

I have given part time to the State Board for Vocational Education, acting as Director of Vocational Education. In this capacity I have been advisory to the State Supervisors of Agriculture and Home Economics, and Trade and Industrial Education.

I have prepared a number of bulletins on the subject of Vocational Education, and assisted in the development of the plans for part time schools under the provisions of the James law. In cooperation with the public school authorities of the State, we are endeavoring to develop the best types of vocational schools in Michigan; and we believe that we occupy a leading position in this new field of vocational education. Our literature, blank forms and general regulations, have been called for by nearly all of the other states.

I have held several conferences for vocational teachers during the year, and shall have one week's conference with the teachers of agriculture during the summer school of 1920. The Department of Home Economics will also have a conference for home economics teachers during the summer school.

Notwithstanding the great prosperity in all industrial lines and the

high wages offered to young men, we have been able to hold a large percentage of our students in educational work, and we believe the outlook for the future is very promising.

Respectfully submitted,

W. H. FRENCH,

Professor of Agricultural Education.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEAN OF ENGINEERING.

Dr. F. S. Kedzie, President Michigan Agricultural College.

Dear Sir: This is my thirteenth annual report as Dean of Engineering.

Personnel.

The teaching and clerical personnel of the several departments of the Division of Engineering are named in the reports submitted by the heads of the respective departments, as follows:

Civil Engineering, Prof. H. K. Vedder.

Drawing and Design, Prof. R. K. Steward.

Electrical Engineering, Prof. A. R. Sawyer.

Mechanical Engineering, Prof. H. B. Dirks.

The routine work of my office has been ably handled by Miss Agnes McCann under my general direction.

I am very grateful to all the members of the teaching and clerical staffs of the division for their cooperation during the year.

Enrollment.

The enrollment of four-year students in engineering reached a record mark, due to the very large enrollment of freshmen which more than offset the shortage in the upper classes caused by the war.

The official figures by classes and courses are given herewith:

	Chem. E.	C. E.	E. E.	M. E.	Total.
Graduate	1				
Senior	8	21	11	9	49
Junior	6	27	15	25	73
Sophomore	13	36	31	28	114
Freshmen	39	51	68	63	224
Total					460

COURSE OF STUDY.

Beginning next fall, the new courses of study, set forth in the last catalog, will be effective for all men in engineering.

Equipment.

No extraordinary additions to equipment have been made, except by the Department of Mechanical Engineering, which was enabled by a special appropriation, to take advantage of the provisions of the Cald-

well Bill allowing technical colleges, universities and schools to purchase surplus machine tools from the War Department at 15 per cent of cost. About \$7500 has been expended by the department for an assortment of machine tools of modern types and in excellent condition. See also report of Prof. H. B. Dirks.

Major M. F. Loomis, '95, Chief of Cleveland District Salvage Board, War Department, rendered invaluable service to the College in the selection and procuring of these tools.

Major P. M. Chamberlain, '89, Chief of Chicago District Salvage Board, also rendered valuable assistance.

It is very gratifying to have the assistance of our alumni in the advancement of the work.

It is unfortunate that the scope of the Caldwell Bill was not broad enough to make it possible for the schools to procure, on like terms, equipment for other lines than shop-work.

Needs.

The Departments of Civil Engineering and Electrical Engineering require generous appropriations for equipment, not only to bring them to a *pre-fire* status but to meet the needs of the new courses and the increased enrollment. I hope that these needs can be met fully, at an early date.

There should be a closer relation than now exists between the division and the Department of Chemistry, in order to promote the interests of students in engineering chemistry.

Expansion.

The experiment station idea should be formally recognized by a suitable organization, with funds to support research in engineering, german to the great manufacturing, agricultural and public works enterprises of the State of Michigan.

Respectfully submitted,

G. W. BISELL,

Dean of Engineering.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF CIVIL ENGINEERING.

President F. S. Kedzie, College.

Dear Sir:—As we approached the opening of the college year just past, this department faced many uncertainties. No one knew how many students would return to continue their studies in civil engineering from the point at which the war interrupted them. It was impossible to closely estimate the number of teachers needed and the equipment of instruments for field work in surveying.

Actual attendance was much larger than had been expected, hence our preparation came near to being inadequate. However, an unexpectedly large enrollment is always more pleasing to contemplate than its opposite, and the situation was met by increasing some class sections beyond the desirable limit and by close figuring on the use of equipment. Also, an extra teacher was engaged for the spring term. On the whole the year presents a record of activities more nearly normal than was supposed possible, with very wholesome and satisfactory results.

Before the opening of the fall term, Associate Professor C. A. Melick withdrew from his connection with the College to take up engagement with the State Highway department. The vacancy thus created was filled by the appointment of Mr. Chester L. Allen, as Assistant Professor. The department teaching staff for the year included the names listed below in the order of seniority of appointment. There were no withdrawals during the year. Mr. E. H. Spencer acted as instructor only during the spring term, and has no intention of continuing on the teaching staff.

H. K. Vedder, C. E., Professor of Civil Engineering.

C. M. Cade, C. E., Assistant Professor of Civil Engineering.

R. G. Saxton, C. E., Assistant Professor of Civil Engineering.

W. W. Hitchcock, C. E., Assistant Professor of Civil Engineering.

B. K. Philp, C. E., Assistant Professor of Civil Engineering.

C. L. Allen, C. E., M. S., Assistant Professor of Civil Engineering.

E. H. Spencer, B. S., Instructor in Civil Engineering.

The tabulation which follows will answer all questions with reference to the teaching schedule, the number of classes and the attendance therein.

CLASS WORK—CIVIL ENGINEERING DEPARTMENT FOR COLLEGE YEAR 1919-1920.

FALL TERM 1919.

Class.	Subject.	No. of Course.	Instructor.	No. Hrs. per week.	Number Students in Class.
Sophomores	Surveying (Class)	C. E. 1a	Prof. Hitchcock	2	33
Sophomores	Surveying (Class)	C. E. 1a	Prof. Saxton	2	39
Sophomores	Surveying (Class)	C. E. 1a	Prof. Hitchcock	2	33
Sophomores	Surveying (Class)	C. E. 1a	Prof. Cade	2	33
Sophomores	Surveying (Field)	C. E. 1a	Prof. Philp	2	30
Sophomores	Surveying (Field)	C. E. 1a	Prof. Hitchcock	2	40
Sophomores	Surveying (Field)	C. E. 1a	Prof. Philp	2	30
Sophomores	Surveying (Field)	C. E. 1a	Prof. Hitchcock	2	23
Sophomores	Surveying (Class)	C. E. 1b	Prof. Allen	2	15
Sophomores	Surveying (Class)	C. E. 1b	Prof. Philp	2	17
Sophomores	Surveying (Field)	C. E. 1b	Prof. Allen	4	15
Sophomores	Surveying (Field)	C. E. 1b	Prof. Cade	4	19
Juniors	Mechanics	C. E. 4a	Prof. Allen	5	17
Juniors	Mechanics	C. E. 4a	Prof. Philp	5	18
Juniors	Mechanics	C. E. 4a	Prof. Allen	5	18
Juniors	Mechanics	C. E. 4a	Prof. Philp	5	17
Juniors	Adv. Surveying (Class)	C. E. 6	Prof. Cade	3	20
Juniors	Adv. Surveying (Class)	C. E. 6	Prof. Philp	3	32
Juniors	Adv. Surveying (Class)	C. E. 6	Prof. Cade	3	17
Juniors	Adv. Surveying (Field)	C. E. 6	Prof. Hitchcock	4	10
Juniors	Adv. Surveying (Field)	C. E. 6	Prof. Saxton	4	17
Juniors	Adv. Surveying (Field)	C. E. 6	Prof. Hitchcock	4	18
Juniors	Adv. Surveying (Field)	C. E. 6	Prof. Hitchcock	4	26
Seniors	Graphic Statics	C. E. 4d	Prof. Allen	3	19
Seniors	Hydraulics	C. E. 5	Prof. Saxton	5	27
Seniors	Hydraulics	C. E. 5	Prof. Cade	5	23
Seniors	Hydraulic Laboratory	C. E. 5a	Prof. Saxton	4	21
Seniors	Higher Surveying (Class)	C. E. 6b	Prof. Vedder	1	18
Seniors	Higher Surveying (Field)	C. E. 6b	Prof. Vedder	4	18
Seniors	Bridge Stresses	C. E. 8a	Prof. Vedder	3	20
Total				98	683

DEPARTMENT REPORTS.

61

CLASS WORK—CIVIL ENGINEERING DEPARTMENT FOR COLLEGE YEAR 1919-1920.

WINTER TERM 1920.

Class.	Subject.	No. of Course.	Instructor.	No. Hrs. per week.	Number Students in Class.
Sophomores.....	Sand, Cement and Concrete (Class)	C. E. 16a	Prof. Allen	2	36
Sophomores.....	Sand, Cement and Concrete (Lab.)	C. E. 16a	Prof. Allen, Prof. Hitchcock ..	4	18
Sophomores.....	Sand, Cement and Concrete (Lab.)	C. E. 16a	Prof. Allen, Prof. Hitchcock ..	4	18
Juniors, Seniors	Agricultural Engineering.....	C. E. 3	Prof. Vedder	3	12
Juniors.....	Mechanics	C. E. 4b	Prof. Philp	5	16
Juniors.....	Mechanics	C. E. 4b	Prof. Cade	5	15
Juniors.....	Mechanics	C. E. 4b	Prof. Philp	5	20
Juniors.....	Mechanics	C. E. 4b	Prof. Hitchcock.....	5	20
Juniors.....	Topographic Mapping (Lab)	C. E. 7a	Prof. Cade, Prof. Saxton	6	29
Seniors	Bridge Analysis and Design (Lab.)	C. E. 8b	Prof. Vedder, Prof. Philp ..	8	21
Seniors	Masonry and Arches (Class).....	C. E. 9	Prof. Allen	3	21
Seniors.....	Masonry and Arches (Lab.).....	C. E. 9	Prof. Allen	4	21
Seniors.....	Pavements	C. E. 10	Prof. Saxton	2	15
Seniors	Experimental Laboratory	C. E. 12	Prof. Hitchcock, Prof. Saxton	6	22
Seniors	Water Supply	C. E. 15	Prof. Saxton.....	1	10
Seniors.....	Water Supply	C. E. 15	Prof. Cade	1	11
Total .....	.....	.....	.....	70	305

CLASS WORK -- CIVIL ENGINEERING DEPARTMENT FOR COLLEGE YEAR 1919-1920.

SPRING TERM 1920.

Class.	Subject.	No. of Course.	Instructor.	No. Hrs. per week.	Number Students in Class.
Sophomores	Surveying and Leveling (Class)	C. E. 1e	Mr. Spencer	3	16
Sophomores	Surveying and Leveling (Class)	C. E. 1e	Prof. Philp	3	16
Sophomores	Surveying and Leveling (Class)	C. E. 1e	Mr. Spencer	3	17
Sophomores	Surveying and Leveling (Class)	C. E. 1e	Prof. Hitchcock	3	18
Sophomores	Surveying and Leveling (Field)	C. E. 1e	Mr. Spencer, Prof. Philp	4	16
Sophomores	Surveying and Leveling (Field)	C. E. 1e	Prof. Hitchcock, Mr. Spencer	4	32
Sophomores	Surveying and Leveling (Field)	C. E. 1e	Mr. Spencer, Prof. Hitchcock	4	18
Sophomores	Surveying Methods (Class)	C. E. 2	Prof. Cade	3	12
Sophomores	Surveying Methods (Class)	C. E. 2	Prof. Saxton	3	11
Sophomores	Surveying Methods (Field)	C. E. 2	Prof. Cade, Prof. Saxton	4	23
Sophomores	Adv. Surveying (Class)	C. E. 6	Prof. Cade	3	11
Sophomores	Adv. Surveying (Class)	C. E. 6	Prof. Hitchcock	3	15
Sophomores	Adv. Surveying (Field)	C. E. 6	Prof. Cade, Prof. Philp	4	28
Juniors	Strength of Materials	C. E. 4e	Prof. Allen	5	14
Juniors	Strength of Materials	C. E. 4e	Prof. Philp	5	15
Juniors	Strength of Materials	C. E. 4e	Prof. Allen	5	19
Juniors	Strength of Materials	C. E. 4e	Prof. Philp	5	25
Juniors	Topographic Surveying (Class)	C. E. 6a	Prof. Cade	2	12
Juniors	Topographic Surveying (Class)	C. E. 6a	Prof. Hitchcock	2	12
Juniors	Topographic Surveying (Field)	C. E. 6a	Prof. Cade, Prof. Hitchcock	4	24
Juniors	Railroad Surveying (Class)	C. E. 7	Prof. Saxton	3	16
Juniors	Railroad Surveying (Class)	C. E. 7	Prof. Allen	3	16
Juniors	Railroad Surveying (Field)	C. E. 7	Prof. Saxton, Prof. Allen	4	30
Juniors and Seniors	Road Construction (Class)	C. E. 17	Prof. Saxton	2	7
Juniors and Seniors	Road Construction (Field)	C. E. 17	Prof. Saxton	6	7
Seniors	Thesis (4 Sections)	C. E. 11	Prof. Vedder, Prof. Allen, Prof. Cade, Prof. Saxton	20	20
Seniors	Contracts and Specifications	C. E. 13	Prof. Vedder	3	41
Seniors	Astronomy (Class)	C. E. 11	Prof. Vedder	2	21
Seniors	Astronomy (Field)	C. E. 11	Prof. Vedder, Prof. Philp	2	21
Total				117	536

The following text-books have been used in our classes during the year: Merriman & Jacoby's Roofs & Bridges, Vol. I & III; Malcolm's Graphic Statics; Hughes & Stafford's Hydraulics; Poorman's Mechanics; Baker's Masonry Construction; Harger & Bonney's Highway Engineers' Handbook; Blanchard's American Highway Engineers' Handbook; Turneure & Russell's Public Water Supplies; Metcalf & Eddy's American Sewerage Practice, Vol I; Hosmer's Astronomy; Tucker's Contracts in Engineering; Ingram's Geodetic Surveying; Boyd's Strength of Materials; Allen's Railroad Curves & Earthwork (with Tables); Breed & Hosmer's Surveying, Vols. I & II; Vedder's Notes on Surveying, and Hool & Johnson's Concrete Engineers' Handbook.

The total expenditure by the department during the year for all purposes has been \$2,623.89. During the same period the sum of \$618 has been turned in for class and examination fees. Our biennial inventory for 1920 shows an aggregate of \$17,965.73 as against \$14,116.86 in 1918.

Respectfully submitted,

H. K. VEDDER,

Professor of Civil Engineering.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF MECHANICAL ENGINEERING.

Dr. F. S. Kedzie, President.
Michigan Agricultural College.
Dear Sir:

The following is a brief report of the Department of Mechanical Engineering for the year ending June 30, 1920.

The personnel of the department at the end of the year was as follows:

H. B. Dirks, Professor of Mechanical Engineering.
W. E. Reuling, Assistant Professor of Mechanical Engineering.
W. G. Hildorf, Assistant Professor of Mechanical Engineering.
D. L. Jones, Instructor in Mechanical Engineering.
A. P. Krentel, Foreman of Wood Shop.
G. J. Posthumus, Instructor in Wood Shop.
D. T. Millard, Instructor in Wood Shop.
G. C. Wright, Foreman of Machine Shop.
W. L. Watt, Instructor in Machine Shop.
C. N. Rix, Instructor in Machine Shop.
J. A. Eicher, Foreman of Foundry.
Andrew Watt, Instructor in Forge Shop.
E. C. Crawford, Laboratory Engineer.
J. F. Hinceline, Mechanician.
Ray Pearson, Storekeeper.

Mr. W. L. Watt was appointed October 1st, 1919 and takes the place left vacant by the resignation of Mr. Bigelow.

Mr. D. T. Millard, was appointed January 1st, 1920, and relieved the stress under which Mr. Krentel and Mr. Posthumus were working during the fall term.

Mr. C. N. Rix, while still having oversight of the stock-room, was made instructor in order to relieve the condition due to the placing of machine shop work in the freshmen year, and his position as storekeeper, has been filled by Mr. Ray Pearson.

The large classes in the steam laboratory necessitated an additional man, and being unable to obtain an applicant to permanently fill this position, Mr. D. L. Jones, of the class of 1916, M. A. C., was employed during the winter and spring terms.

In addition to the work of the fall, winter, and spring terms, the department assisted in two terms of summer work in which nine courses were taught to a total of sixty-one students, and also in two Truck and Tractor courses of the winter courses in Agriculture. In the latter work one hundred and sixty men were given instruction in truck engines, ignition and lighting, carburetion, chassis construction, and forge shop. Of these courses, the forge work was given by Mr. A. Watt in addition to his regular college teaching, and the others were given by Messrs. Beck, Brault, Foote, Halsted and Leland, who were employed especially for this work.

I wish here to express my appreciation of the material assistance received from the Duplex Truck Company, Reo Motor Car Company and Olds Motor Works in the way of trucks and parts which were loaned to us for the above courses.

Of the new equipment received during the year, I wish especially to express appreciation of the machine tools added to the shops, as a result of the generous action of the Board in appropriating \$10,000 so that advantage could be taken of the Caldwell Bill for the purchase of Government machine tools at 15% of their cost. This has brought the equipment of the machine shop up to the requirements of modern practice and will be of great assistance in the regular machine shop courses and also in the new courses in Industrial Engineering, to be offered to the seniors the coming year.

In addition to the above, a Brinell Machine, recently purchased will add much to the courses in the heat treatment of steel. The gas furnaces purchased for this work last year were installed during the summer, and have proved a great aid.

During the year the junior and senior courses have been revised, the most noteworthy changes being the introduction of humanistic studies and group options in the senior year. Three options were introduced, viz. automotive engineering, industrial engineering, and steam engineering.

I wish to express my appreciation of the work of the various members of the department, during the past year. The teaching schedule of the year is shown in the tables that follow.

Respectfully submitted,

H. B. DIRKS,

Professor of Mechanical Engineering.

East Lansing, Mich., June 30, 1920.

DEPARTMENT REPORTS.

65

TABLE 1.—CLASS WORK OF DEPARTMENT OF MECHANICAL ENGINEERING.—FALL TERM 1919

Class.	Subject.	No. of Course.	Teacher.	Hrs. per week each Student.	No. of Students.	Student Hrs. per week.
Freshmen.....	Elements of Engineering	1	Dean Bissell	1	118	118
Freshmen.....	Wood Shop.....	2d	Mr. Krentel, Mr. Posthumus	6	108	648
Juniors.....	Machine Shop.....	2h	Mr. Wright Mr. Watt Mr. Rix	6	29	174
Juniors.....	Machine Shop.....	2j	Mr. Wright Mr. Watt Mr. Rix	6	1	6
Seniors.....	Forge Shop.....	2k	Prof. Hildorf	6	16	96
Freshmen.....	Forge Shop.....	3d	Mr. Watt	6	96	588
Seniors.....	Gas Power Engineering	8c	Prof. Reuling	3	29	87
Juniors.....	Metallurgy.....	11a	Prof. Hildorf	2	71	142
Juniors.....	Engineering.....	13b	Prof. Reuling	1	1	16
Seniors.....	Engineering Lab.....	13c	Prof. Reuling	1	17	188
Seniors.....	Heating and Ventilation	18a	Prof. Dirks	3	9	27
Seniors.....	Costs and Accounting	18c	Dean Bissell	2	51	102
Freshmen.....	Pattern Work.....	31	Mr. Krentel, Mr. Posthumus	4	139	556
Sophomores.....	Forge Shop.....	41	Mr. Watt	1	62	248
Sophomores.....	Foundry.....	51	Mr. Eicher	1	69	276
Freshmen.....	Machine Shop.....	61	Mr. Wright Mr. Watt Mr. Rix	4	76	304
Total.....					958	3,612

TABLE 2.—CLASS WORK OF DEPARTMENT OF MECHANICAL ENGINEERING.—WINTER TERM, 1920.

Class.	Subject.	No. of Course.	Teacher.	Hrs. per week each Student.	No. of Students.	Student Hrs. per week.
Juniors.....	Machine Shop.....	2i	Mr. Wright Mr. Watt Mr. Rix	6	60	365
Senior.....	Machine Shop.....	2k	Mr. Wright Mr. Watt Mr. Rix	6	1	
Juniors.....	Steam Engines and Boilers.....	7a	Mr. Jones	3	78	234
Juniors.....	Engineering Lab.....	13a	Prof. Reuling, Mr. Jones	1	74	296
Seniors.....	Engineering Lab.....	13d	Prof. Reuling, Mr. Jones	8	11	88
Seniors.....	Power Station Design.....	18b	Prof. Dirks	3	19	57
Freshmen.....	Pattern Work.....	31	Mr. Krentel Mr. Posthumus	4	120	480
Sophomore.....	Forge Shop.....	42	Mr. Millard Prof. Hildorf	4	49	196
Sophomore.....	Foundry.....	51	Mr. Eicher	4	2	164
Sophomore.....	Foundry.....	52	Prof. Hildorf	4	29	
Freshmen.....	Machine Shop.....	61	Mr. Wright Mr. Watt Mr. Rix	4	66	264
Total.....					1,590	2,115

TABLE 3.—CLASS WORK OF DEPARTMENT OF MECHANICAL ENGINEERING—SPRING TERM, 1920.

Class.	Subject.	No. of Course.	Teacher.	Hrs. per week each Student.	No. of Students.	Student Hrs. per week.
Freshmen.....	Woodshop.....	2d	{ Mr. Krentel..... Mr. Posthumus..... Mr. Millard.....	6	86	516
Juniors.....	Machine Shop.....	2j	{ Mr. Wright..... Mr. Watt..... Mr. Rix.....	6	40	240
Freshmen.....	Forge Shop.....	3d	Mr. Watt.....	6	82	492
Juniors.....	Engineering Lab.....	13b	Prof. Reuhing, Mr. Jones.....	4	74	296
Juniors.....	Thermodynamics.....	17a	Prof. Dirks.....	4	52	208
Juniors.....	Thermodynamics.....	17b	Mr. Jones.....	4	23	92
Seniors.....	Thesis.....	19a	Prof. Dirks.....	20	9	180
Freshmen.....	Pattern Work.....	32	{ Mr. Krentel..... Mr. Posthumus..... Mr. Millard.....	4	114	456
Sophomore.....	Forge Shop.....	42	Prof. Hildorf.....	4	25	100
Sophomore.....	Foundry.....	52	Prof. Hildorf, Mr. Eicher.....	4	25	100
Freshmen.....	Machine Shop.....	61	{ Mr. Wright..... Mr. Watt..... Mr. Rix.....	4	59	236
Total.....					589	2,916

REPORT OF THE DEPARTMENT OF ELECTRICAL ENGINEERING.

President F. S. Kedzie, East Lansing, Mich.

My Dear President Kedzie:—The summer of 1919 was the first one in which the Department of Electrical Engineering participated in the summer school work. It was the last of the war tangle in our educational work; now we have the aftermath.

I am not sure that the faculty acted wisely in broadening the scope of engineering education at this institution last year, when we offered more options in the departments and began a differentiation further down in the course. However, we are pledged to it for a while.

This department gives instruction in electrical subjects to every engineering student who survives the sophomore year. I think the year just closed has been the best in the history of the department—the supplementary activities such as work in the local branch of the American Institute of Electrical Engineers serves to stimulate the students to better work. The students themselves take quite an active part in providing the department with needed apparatus which can be assembled by them.

In this department we shall continue to adhere to the idea of a strong fundamental course in direct current work in the junior year and a strong fundamental course in alternating currents in the senior year supplemented all along by work in advanced physics, known in our course as Electrical Measurements and introduced in the catalogue under Electrical Engineering, 14, 14b, 15, and 16,

While wireless telegraphy and telephony comes in only incidentally in the course, we try to keep the subject before the minds of the students throughout the course and at the same time encourage the high school boys of the State to "dabble" in it—some of them more than "dabble" in it and become quite proficient before they attend any class work given on the subject.

It seems entirely possible so far as the technology is concerned, to communicate with the farmers of the State by means of the wireless telephone, and any boy or farmer can use the ordinary receiving "setup" for listening. The greatest difficulty will be to overcome the refusal of the makers of the "tubes" to allow such use.

The relation between electricity and chemistry has long been intimate, and since the war the need for trained men who understand this relation is quite urgent, it seems as though this should be given some attention by this College; and the Electrical and Chemical departments are planning to call the attention of the students to the opportunity of engaging in commercial work based on this relation. Electrical Engineering 35, is a five credit course introduced as a beginning along this line and we hope it will meet with response by them.

Mr. P. G. Andres who has been with the department for two years has been given a year's leave of absence to go into practical work, and Professor L. S. Foltz of the Colorado Agricultural College has been engaged in his place.

Yours very truly,

A. R. SAWYER,

Professor of Electrical Engineering.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF DRAWING AND DESIGN.

President F. S. Kedzie,

East Lansing, Michigan.

Dear Sir:

I herewith present to you my fourth annual report as head of the Department of Drawing and Design for the year ending June 30, 1920.

The personnel of the department at the opening of the college year was as follows:

Mr. R. K. Steward, C. E., Professor.

Mr. Chace Newman, Associate Professor.

Mr. L. N. Field, B. M. E., Associate Professor.

Mr. A. G. Scheele, A. M., Assistant Professor.

Mr. J. W. Steward, B. M. E., Assistant Professor.

Mr. E. H. Stewart, B. S. in M. E., Instructor.

Miss C. L. Holt, Instructor.

Mr. M. B. Chapin, Ph. D., Instructor.

Mr. J. Rising, M. E., Instructor.

Miss Edith Butler, Instructor.

*Mr. O. W. Fairbanks, B. S., Instructor.

*Appointed January 1, 1920.

It is with a feeling of gratification that this report is made as there has been a question as to how readily our returning soldiers would be able to settle down and adapt themselves to the monotony of school work, but in my mind there is no doubt as to their attitude. They have returned to us with a strong appreciation of responsibility and I feel that the present school year stands out as a mile stone in the history of M. A. C. because of this fact.

Mr. M. B. Chapin was given a leave of absence during the winter term to complete his work at the University of Chicago for a PhB. degree.

The development of courses along art lines has proceeded with gratifying results and the opportunity for election of subjects by the women students has been taken advantage of so that we are now carrying on work with girls in each of the four years.

The change in the course for engineering students, whereby the freshmen now get three terms of Mechanical Drawing and Machine Design followed in the sophomore year by two terms of Descriptive Geometry and one of Freehand Drawing, is proving entirely satisfactory as it prepares our freshmen to take up work in commercial drafting offices during their summer vacation, and we find the student is more matured and better qualified to handle descriptive geometry than he was when it was given in the freshman year.

In closing I wish to again express my appreciation for the support which I have been given by the members of the department staff.

The following is a teaching schedule of the department.

Respectfully submitted,

R. K. STEWARD,

Professor of Drawing & Design.

East Lansing, Mich., June 30, 1920.

DEPARTMENT REPORTS.

69

TEACHING SCHEDULE DEPARTMENT OF DRAWING AND DESIGN.

FALL TERM 1919.

Class.	Subject.	No.	Instructor.	Hours.	No. of Students.
Freshmen	Freehand Drawing	1b-1	Miss Butler	6	19
Freshmen	Freehand Drawing	1b-2	Miss Holt	6	20
Freshmen	Freehand Drawing	1b-3	Miss Holt	6	18
Freshmen	Freehand Drawing	1b-4	Miss Butler, Mr. Chapin	6	48
Freshmen	Freehand Drawing	1b-5	Miss Butler	6	22
Freshmen	Freehand Drawing	1b-6	Mr. Chapin	6	18
Freshmen	Mechanical Drawing	4ab-1	Mr. Rising	6	29
Freshmen	Mechanical Drawing	4ab-2	Mr. Stewart	6	24
Freshmen	Mechanical Drawing	4ab-3	Mr. Stewart	6	27
Freshmen	Mechanical Drawing	4ab-4	J. W. Steward	6	23
Freshmen	Mechanical Drawing	4ab-5	Mr. Stewart	6	31
Freshmen	Mechanical Drawing	4ab-6	Mr. Rising	6	25
Freshmen	Mechanical Drawing	4ab-7	J. W. Steward	6	28
Freshmen	Mechanical Drawing	4ab-8	Mr. Rising	6	27
Sophomores	Freehand Drawing	1m	Mr. Scheele	10	16
Sophomores	Desc. Geometry	5ab	Mr. Field	3	16
Sophomores	Machine Design	6a-1	Mr. Field	6	17
Sophomores	Machine Design	6a-2	J. W. Steward	6	21
Sophomores	Machine Design	6a-3	Mr. Rising	6	32
Sophomores	Machine Design	6a-4	Mr. Field	6	32
Juniors	Shades, Shadows and Perspective	7	Mr. Newman	6	24
Juniors	Kinematics	6c	Mr. Field	4	21
Juniors	Ad. Drawing and Design	1p	Mr. Scheele	6	2
Juniors and Seniors, Ags. and Forest	Mechanical Drawing	3b	J. W. Steward	6	3
Juniors and Seniors	Freehand Drawing	1c	Mr. Newman	10	5
Seniors	Ad. Drawing and Design	1s	Mr. Scheele	4	2
Seniors	History of Art	2b	Miss Holt	3	15
Seniors	House Architecture	9-1	Mr. Newman	6	24
Seniors	House Architecture	9-2	R. K. Steward	6	17
Total					606

TEACHING SCHEDULE DEPARTMENT OF DRAWING AND DESIGN.

WINTER TERM 1920.

Class.	Subject.	No.	Instructor.	Hours.	No. of Students.
Freshmen	Freehand Drawing	1h-1	Miss Butler	4	21
Freshmen	Freehand Drawing	1h-2	Miss Butler		
Freshmen	Freehand Drawing	1h-3	Mr. Scheele	4	16
Freshmen	Freehand Drawing	1h-4	Miss Butler	4	19
Freshmen	Freehand Drawing	1h-5	Miss Butler	4	21
Freshmen	Freehand Drawing	1h-6	Miss Holt	4	18
Freshmen	Freehand Drawing	1h-7	Miss Holt	4	19
Freshmen	Freehand Drawing	1h-8	Miss Butler	4	23
Freshmen	Mechanical Drawing	4ab	Mr. Newman	6	9
Freshmen	Machine Design	16a-1	Mr. Fairbanks	10	26
Freshmen	Machine Design	16a-2	J. W. Steward	10	25
Freshmen	Machine Design	16a-3	Mr. Fairbanks	10	21
Freshmen	Machine Design	16a-4	Mr. Rising	10	29
Freshmen	Machine Design	16a-5	J. W. Steward	10	22
Freshmen	Machine Design	16a-6	E. H. Stewart	10	20
Freshmen	Machine Design	16a-7	E. H. Stewart	10	20
Freshmen	Machine Design	16a-8	R. K. Steward	10	21
Sophomores	Freehand Drawing and Color	1n	Mr. Scheele	10	16
Sophomores	Desc. Geometry	5ab	Mr. Field	3	11
Sophomores	Machine Design	6b-1	J. W. Steward	6	12
Sophomores	Machine Design	6b-2	Mr. Rising	6	26
Sophomores	Machine Design	6b-3	J. W. Steward	6	27
Sophomores	Machine Design	6b-4	Mr. Field	6	22
Sophomores	Machine Design	6b-5	E. H. Stewart	6	15
Juniors and Seniors	Freehand and Mech. Drawing	2c	Mr. Newman	10	6
Juniors	Ad. Drawing and Color	1q	Mr. Scheele	6	3
Juniors	Machine Design	6d	Mr. Field	3	26
Seniors	Ad. Drawing and Color	1t	Mr. Scheele	4	1
Seniors	History of Painting	2e	Miss Holt	3	34
Seniors	Engine Design	8b	Mr. Field	8	9
Total					540

DEPARTMENT REPORTS.

71

TEACHING SCHEDULE DEPARTMENT OF DRAWING AND DESIGN.

SPRING TERM 1920.

Class.	Subject.	No.	Instructor.	Hours.	No. of Students.
Freshmen.....	Machine Design.....	16b-1.....	E. H. Stewart.....	6	18
Freshmen.....	Machine Design.....	16b-2.....	Mr. Rising.....	6	20
Freshmen.....	Machine Design.....	16b-3.....	Mr. Field.....	6	16
Freshmen.....	Machine Design.....	16b-4.....	J. W. Steward.....	6	13
Freshmen.....	Machine Design.....	16b-5.....	Mr. Rising.....	6	10
Freshmen.....	Machine Design.....	16b-6.....	Mr. Fairbanks.....	6	10
Freshmen.....	Machine Design.....	16b-7.....	Mr. Fairbanks.....	6	13
Freshmen.....	Machine Design.....	16b-8.....	J. W. Steward.....	6	11
Freshmen.....	Machine Design.....	16b-9.....	E. H. Stewart.....	6	12
Freshmen.....	Machine Design.....	16b-10.....	R. K. Steward.....	6	14
Freshmen.....	Machine Design.....	16b-11.....	E. H. Stewart.....	6	11
Freshmen.....	Machine Design.....	16b-12.....	Mr. Rising.....	6	10
Freshmen.....	Machine Design.....	16a.....	Mr. Fairbanks.....	6	12
Sophomores.....	Freehand Drawing and Color.....	1c.....	Mr. Scheele.....	10	17
Sophomores.....	Freehand Drawing.....	1w-1.....	Miss Butler.....	4	30
Sophomores.....	Freehand Drawing.....	1w-2.....	Miss Butler.....	4	11
Sophomores.....	Freehand Drawing.....	1w-2a.....	Mr. Chapin.....	4	15
Sophomores.....	Freehand Drawing.....	1w-3.....	Miss Butler.....	4	15
Sophomores.....	Freehand Drawing.....	1w-4.....	Mr. Chapin.....	4	11
Sophomores.....	Freehand Drawing.....	1w-5.....	Miss Holt.....	4	11
Sophomores.....	Freehand Drawing.....	1w-6.....	Mr. Chapin.....	4	16
Juniors and Seniors.....	Freehand and Mech. Drawing.....	3c.....	Mr. Chapin, Mr. Newman.....	10	3
Juniors.....	Ad. Drawing and Color.....	1r.....	Mr. Scheele.....	6	3
Juniors.....	Machine Design.....	8a.....	Mr. Field, J. W. Steward.....	4	24
Seniors.....	History of American Painting.....	2d.....	Miss Holt.....	3	46
Seniors.....	Machine Design.....	6c and 6f.....	Mr. Field.....	6	10
Total.....					371

REPORT OF THE DEAN OF HOME ECONOMICS.

My dear President Kedzie:

Permit me to present the following report for the Division of Home Economics for the year 1919-1920.

ENROLLMENT.

The enrollment of young women for the year 1919-1920 was 353, and for the year 1918-1919 it was 329. The enrollment by classes for the year 1919-1920 was:

Graduate	1
Seniors	65
Juniors	57
Sophomores	72
Freshmen	146
Special	12
<hr/>	
Total	353

INSTRUCTIONAL FORCE.

There have been several changes in the instructional force. It was with regret that we accepted the resignation of Miss Edna Garvin, Associate Professor of Household Science. Miss Garvin had rendered excellent service for three years. Miss Osee Hughes of the University of Kansas was appointed Assistant Professor of Household Science, and Miss Helen Gillett of the University of Montana, Graduate Assistant in Household Science. Miss Cecil VanSteenburg, Head of the Household Arts department at Montana State College, was appointed Assistant Professor of Household Arts, and Miss Minerva Fouts of Chicago University, Instructor in Household Arts.

THE HOUSEHOLD ARTS DEPARTMENT.

In the catalog for 1919-1920 the former Domestic Art department was listed as the Household Arts department. This term seems broader and better chosen to represent the course which is planned to train young women to be better home makers, with a keen appreciation for beauty, economy and technical skill involved in clothing and all house furnishings.

Under the present economic conditions the American housewife is, to a large extent, a consumer rather than a producer of the world's products. She must be trained in the choice and selection of materials for clothing for herself and family and the furnishing of her house, as

well as in sewing and the construction of garments. The art of selection involves a knowledge of textures and fibers, an appreciation of suitable and becoming colors, lines and styles, and a judgment of quality and durability.

To meet this demand the content of some of the former courses in the Household Arts department has been revised and several new courses have been added; so that the work of the Household Arts department now consists of the following courses:

Sewing—Freshman 2 terms.

The rudiments of sewing. Construction of simple garments.
Skill with the sewing machine.

Textiles—Sophomore 1 term.

A study of the fibers. The characteristics and wearing qualities of all fabrics. Tests for adulteration. The hygienic, economic and aesthetic phases of fabrics.

Clothing—Junior 2 terms.

Making of garments. Study of economic and industrial conditions. Budget making.

Theory of Design. Freshman 2 terms.

A study of fundamental principles to be applied later.

Costume Design—elective.

Millinery—elective

Applied Design—elective

Advanced Clothing—elective.

Many of the graduates who have specialized in Household Arts do not wish to teach after leaving college, and it is the aim of this department to acquaint the students with some of the opportunities which are open to women in various fields. With further special training these graduates might turn to textile chemistry, costume designing, house furnishing, or trained salesmanship.

An effort is made to keep in touch with the development of household arts work throughout the country. The faculty are at present interested in several research problems on text books and courses of study, and it is hoped that the results may aid in the standardization of this work in both high schools and colleges. Also some of the problems of investigation that are promoted by the Committee on the Standardization of Textiles of the National Home Economics Association are being worked out in the household arts classes in clothing.

During the Farmers' Week of 1919 the Household Arts department and the Extension division arranged an exhibit of house furnishings in the form of two comparative rooms, displaying good and bad taste, and of equal cost. There was also an exhibit showing the result of some recent experiments in testing out American dyes, and the removal of stains.

For the Farmers' Week of 1920 a campaign was waged on the economy in household textiles. Suggestions were made for thrift in children's clothing, the renovation and remodeling of both clothing and millinery, and substitutes for the necessary household linens.

During the year 1920 the rooms Nos. 5, 7, and 9 on the first floor of the Woman's Building were given to this department for offices. The former parlor on second floor of the Woman's Building is now used as a textile and design laboratory, and one small room is fitted up as an experimental laboratory for textiles.

THE HOUSEHOLD SCIENCE DEPARTMENT.

A few changes have been made in the course of study and in the manner of presenting the work this year. The freshman food work was moved from the fall to the spring term, so that the young women might get some training in chemistry before undertaking this study. We are well pleased with the way this plan has worked out.

The work in Problem Cookery has increased in interest and popularity. Our research laboratory is proving all too small to meet the demands of the students and the women of the State who are interested in having this work done.

A mechanical household device laboratory was opened in the basement of the Woman's Building at the beginning of the fall term 1919. The equipment of this room consists of washing machines of various types, clothes dryers, all sorts of irons, ironing boards, vacuum cleaners, and other devices for cleaning; water heaters, fireless cookers, oil stoves, cooking utensils, kitchen cabinets, work tables, etc. The greater part of the equipment has been donated outright by commercial firms, or has been loaned on long time contract.

We have found this laboratory invaluable in the teaching of Household Management, and hope that we may have space and money to develop it further in the near future. This laboratory equipment was included in the exhibit during Farmers' Week, and both men and women seemed very much interested in it.

An elective course in Advanced Nutrition has been added. Forty-one seniors elected this course this year and did splendid work.

It is our hope during the coming year to make more practical application of our work in food and nutrition. This we plan to do by starting a nutrition clinic for mothers and children in connection with the Associated Charities in Lansing. Miss May Person who has just been appointed Assistant Professor in Household Science, has had considerable experience in this work. She ran a nutrition clinic at the Henry Street Settlement House in New York City under the direction of Mrs. Mary Swartz Rose.

Our graduates are being called upon to help with this work in other cities, and we are desirous of giving them more specific and helpful training here. It will not only add to their technical training, but will help in developing their spirit of social service.

It has been the aim of the division during the past five years to give the young women a more careful and thorough technical foundation for their work, both along the lines of science and art.

We wish to express our gratitude especially to the Departments of Chemistry, Bacteriology, Biology, Physiology, Drawing, Mathematics and Physics for the kindly cooperation and splendid assistance which they have given us. The training of the young women in English, economics and history has been done equally well.

During the past two years the work along the lines of Education and Practice Teaching has been considerably developed. The success of this work is due to the thorough and enthusiastic work of Miss Elizabeth

Frazer and the kindly and intelligent cooperation of Professor Walter H. French.

Respectfully submitted,
MARY E. EDMONDS,
Dean of Home Economics.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DIVISION OF VETERINARY SCIENCE.

F. S. Kedzie, President,
Michigan Agricultural College.

Dear President Kedzie:—Herewith I present the 10th Annual Report of the Division of Veterinary Science.

The year just closed has been an eventful one within the Veterinary Science division, more particularly regarding changes in the personnel of its faculty and accomplishments. Early in June 1919 Dean R. P. Lyman availed himself of a leave of absence which continued to January 1, 1920, when his resignation became effective, meanwhile Dr. F. W. Chamberlain was in charge of the Veterinary Science division and was made Acting Dean January 1, 1920, for the remainder of the college year. Dr. James W. Benner resigned as Assistant Professor of Veterinary Medicine to take up research work at Cornell, thus more men had to be obtained to carry on the work of the division. 1st Lieut O. A. Taylor was secured as Assistant Professor of Veterinary Medicine and Pharmacology and 1st Lieut. E. K. Sales as Assistant Professor of Surgery and Clinic and with the understanding that he assist also in the Department of Medicine and Pharmacology. Of the work of the several departments, the cooperation and loyalty of the men involved, I have only the heartiest praise. Recommendations affecting the division have been submitted to the Board of Agriculture and are now under consideration, their adoption and support meaning much good to the division, the College and the profession.

During November 1919 Drs. Chamberlain and Hallman attended the annual meeting of the American Veterinary Medical Association at New Orleans, from which much good was derived. Dr. Hallman gave a resume of the A. V. M. A. meeting before the M. A. C. Society of Comparative Medicine.

On February 3rd and 4th the College entertained the Michigan State Veterinary Medical Association. The meeting and entertainment was highly satisfactory to the officers of the Association. The Association separated with the feeling that it had had a good meeting and a greater appreciation of the benefits derived by meeting at M. A. C. and its duties toward her were evident. We hope and believe the Association will come here for its meeting next year. Various members of the Veterinary faculty have attended many meetings of the County Association, notably Jackson, Adrian and Detroit and good to the College has resulted.

At the New Orleans meeting of the A. V. M. A. two private veteri-

ary Colleges were disqualified and dropped from the Civil Service list and a state institution was placed on probation, the former for not living up to the four year entrance requirements. During the last year the Cincinnati and Chicago private veterinary colleges have gone out of existence. An increasing number of vacancies in the profession within the State have come to my notice during the last year thus an increasing duty is devolved upon us to prepare more men for the work, and to do this means we must attract more students and to do that we must have a more definite and complete organization. The following table was prepared by Dean White of Ohio State College and shows in a comparative manner the veterinary student attendance throughout this country.

STATE VETERINARY COLLEGES 1919-1920.

Name of Institution.	First Year.	Second Year.	Third Year.	Fourth Year.	Special.	Totals.
Alabama Polytechnic Institute	17	12	9	7	.....	45
Colorado Agricultural College	35	13	18	20	.....	86
Georgia State College	8	4	4	.....	.....	16
Iowa State College	36	20	25	26	.....	107
Kansas State Agricultural College	32	10	20	21	.....	83
Michigan Agricultural College	9	7	7	8	.....	31
North Dakota Agricultural College	7	5	.....	.....	.....	12
New York State Veterinary College (Cornell)	39	20	24	19	3	105
New York State Veterinary College (N. Y. Univ.)	5	9	8	11	.....	33
Ohio State University	33	16	25	27	1	102
Ontario Veterinary College (Canada)	33	20	17	8	.....	78
University of Pennsylvania	11	9	12	19	4	55
Texas Agricultural and Mechanical College	4	2	4	4	.....	14
State College of Washington	5	4	16	20	.....	45

PRIVATE VETERINARY COLLEGES 1919-1920.

McKillop Veterinary College	21	9	20	31	4	85
St. Joseph Veterinary College	49	24	35	46	.....	154

At our June Commencement 1920 we graduated eight men in Veterinary Medicine namely:—

Gerard Dikmans,
 William A. Erbach,
 Albert E. George,
 Alfred J. Gregg,
 Warren P. S. Hall,
 Lynn C. Palmer,
 Louis R. Pless,
 Ernest E. Redfearn.

A small percentage of these men are planning to enter private practice.

The departmental expenses of the Veterinary division have been lower the past year than formerly, possibly because of our restricted classes and also because the equipment of the division has become more complete for the number of students involved.

The clinical facilities of the division are constantly improving. The following table shows the relative growth of the clinic since the veterinary division was established; it is self explanatory and it should

be noted that the last year's total is approximately twenty-five hundred (2745) cases. A large proportion is ambulatory, which emphasizes the importance of further development in that direction, and that is possible.

COMPARATIVE CLINICAL RECORD.

Year.	Equine.	Bovine.	Ovine.	Sus.	Canine.	Feline.	Aves.	Misc.	Total.	Nature.
1910-11.....									86	Mixed.
1911-12.....										No record.
1912-13.....									357	Mixed.
1913-14.....	40	16	5	22	21	5	2		111	Medical.
	97	139	11	30	66	8	3		354	Surgical.
									465	
1914-15.....	37	22	3	5	26	9	3		105	Medical.
	233	48	2	5	100	28			416	Surgical.
									521	
1915-16.....	122	24	2	24	72	16	18		278	Medical.
	246	132	2	5	117	23	4		529	Surgical.
									807	
1916-17.....	49	22	3	3	24	10			121	Medical.
	161	67	7	11	70	21			337	Surgical.
									458	
1917-18.....	172	233	130	7	126	21	9		698	
1918-19.....	402	255	249	4	134	28	4		1,075	Medical.
	222	410	17	47	81	4	2	2	785	Surgical.
									1,860	
									1,013	Ambulatory.
1919-20.....	211	346	135	116	147	13	2	3	975	Medical.
	383	715	3	383	238	43	2		1,770	Surgical.
	416	999	3	483	263	36			2,200	Ambulatory.
									2,745	Total.

In referring to the clinic of other institutions we note that Cornell for its greater number of students had a clinical record of approximately four thousand cases last year. We can surpass Cornell's record. For a fuller discussion of our last year's clinic see Report of Surgery and Clinic.

DEPARTMENT OF ANATOMY.

The work of this department as usual was maintained by Drs. Chamberlain and Johnson and in addition the former directed the Veterinary division of the College, he also was President of the State Veterinary Medical Association while Dr. Johnson in the spring term taught the subject Pharmacology I. Thus the following table shows only in part the work done and is self explanatory.

Term.	No. of Students.	Credits.	Lectures.	Labora- tory.	Total class hours.
Summer:					
Anatomy 3b.....	5	4	24	72	96
Total.....	5	4	24	72	96
Fall:					
Anatomy 1a.....	13	4	24	72	96
Anatomy 2a.....	8	3	.....	108	108
Anatomy 4.....	8	4	24	72	96
Total.....	29	11	48	252	300
Winter:					
Anatomy 1b.....	11	4	12	72	84
Anatomy 2b.....	6	4	12	108	120
Anatomy 3a.....	12	4	24	72	96
Total.....	29	12	48	252	300
Spring:					
Anatomy 1c.....	9	4	12	108	120
Anatomy 2c.....	5	3	12	72	84
Anatomy 3b.....	10	4	24	72	92
Total.....	24	11	48	252	300
Grand Total.....	87	38	168	828	996

The usual conditions obtain in the lack of suitable housing for gross and microscopic anatomy, with our small classes we get along but not without disadvantages. We should be able to use living animals for quizz work. The equipment is excellent and many microscopic slides have been prepared to illustrate the study of microscopic anatomy. Also many gross specimens have been collected, but we have no convenient place for a museum and much of the material is unavailable for class work.

VETERINARY MEDICINE.

Classes in Junior and Senior Medicine have been combined in the winter and spring terms. This was possible because of small classes and necessary because of a shortage of teaching assistance. Dr. O. A. Taylor has carried on the teaching of Veterinary Medicine also the teaching of Pharmacology except the subject Pharmacology 1 which was taught by Dr. H. E. Johnson as mentioned above. The following tables represent the work in Veterinary Medicine and Pharmacology respectively.

DEPARTMENT REPORTS.

79

VETERINARY MEDICINE.

Term.	No. of Students.	Credits.	Lectures.	Laboratory.	Total class hours.
Fall:					
Medicine 1.....	4	4	48		48
Total.....	4	4	48		48
Winter:					
Medicine 3a.....	5				
Medicine 4b.....	10	4	48		48
Total.....	10	4	48		48
Spring:					
Medicine 3b.....		4			
Medicine 4a.....	17	5	60		
Medicine 5.....		1			
Total.....	17	5	60		60
Grand Total.....	31	13	156		156

PHARMACOLOGY.

Term.	No. of Students.	Credits.	Lectures.	Laboratory.	Total class hours.
Fall:					
Pharm. 2.....	7	5	48	24	72
Pharm. 4a.....	8	3	36		36
Total.....	15	8	84	24	108
Winter:					
Pharm. 4b.....	9	3	36		36
Total.....	9	3	36		36
Spring:					
Pharm. 1.....	4	5	48	24	72
Pharm. 3.....	8	4	36	24	60
Pharm. 4c.....	8	3	36		36
Total.....	20	12	120	48	168
Grand Total.....	44	23	240	72	312

STATE BOARD OF AGRICULTURE.

VETERINARY SCIENCE.

Veterinary Science to agricultural and short course students has been handled for the past year by Dr. E. K. Sales and with a great deal of credit to himself because he has handled the work efficiently; Dr. Sales has also conducted the subject of Zootechnics.

Zootechnics has proved a real live subject the past year and a laboratory fee of five dollars for the course should be charged to cover the cost of prints used, as no suitable text-book on the subject is at present available. The following tables illustrate the work as conducted in the subjects, Veterinary Science and Zootechnics, respectively.

VETERINARY SCIENCE.

Term.	No. of Students.	Credits.	Lectures.	Laboratory.	Total class hours.
Fall: Veterinary Science 2a	33	5	60	.....	60
Total.....	33	5	60	.....	60
Winter: Veterinary Science 2b.....	18	5	60	.....	60
Total.....	18	5	60	.....	60
Spring: Veterinary Science 2c.....	12	5	60	.....	60
Total.....	12	5	60	.....	60
Grand Total.....	63	15	180	.....	180

ZOOTECHNICS.

Winter: Zootechnics	10	3	24	24	48
Total.....	10	3	24	24	48

Some changes in the subject Veterinary Science are desirable. The last hour of the day is unattractive to agricultural students, and the course is too comprehensive for men without a basic training in anatomy and physiology. The senior and junior years are too late in the course to attract men to the veterinary course.

For the work done in the Department of Surgery and Clinic by Drs. Hutton and Sales also work done in the Department of Pathology by Drs. Hallman and Rummells see report of the respective departments.

Again thanking my colleagues for their past hearty cooperation, this is

Respectfully submitted,

F. W. CHAMBERLAIN,

Acting Dean.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF ANIMAL PATHOLOGY.

President F. S. Kedzie, College.

Dear Mr. President:—I herewith submit report of the Department of Animal Pathology for the year ending June 30th, 1920.

The class work for the past year is as follows:

Pathology 1, Fall term, 10 hours per week, 9 students.

Pathology 2a, Fall term, 5 hours per week, 7 students.

Pathology 2b, Spring term, 4 hours per week, 8 students.

Pathology 3, Spring term, 5 hours per week, 8 students.

Pathology 100, Graduate course major, fall and winter terms, 1 student.

Veterinary Science short course, 16 hours, 24 students.

Dr. Runnells has had charge of Pathology 2a, 2b and 3, as well as the routine examination of tissues, autopsy work and class work for short course students, thereby permitting the writer to devote a large part of his time to investigational work. The results of this work may be found in the department's report to the Director of the Experiment Station. That the results of this work are appreciated is indicated by the fact that the writer spent two weeks in Indiana, under the Auspices of Purdue University, lecturing and demonstrating to the veterinarians on the methods of treatment of sterility of cattle.

In addition to the above the writer prepared papers for the following meetings: United States Live Stock Sanitary Association, Chicago, Dec. 3, 1919; Michigan Jersey Cattle Club, East Lansing, January, 1920; Michigan State Veterinary Medical Association, Feb. 3, 1920; Northwestern Ohio Veterinary Medical Association, Toledo, March 3, 1920.

During the year we have held autopsies on 134 animals. Among these we have recorded the following:

Horse,	Torsion of mesentery	1
Cattle,	Acute gastro-intestinal catarrh	1
	Acute gastro-intestinal intoxication	4
	Fibrinous Oesophagitis and Mechanical pneumonia	1
	Generalized peritonitis	1
	Lobar pneumonia	2
	Septicaemia	3
	Tuberculosis	2
Sheep,	Hemonchus contortus	1
	Uncinariasis	2

Swine,	Acute parenchymatous nephritis	1
	Fibrinous gastro-enteritis	1
	Hemorrhoids	1
	Hog Cholera	1
	Lobar pneumonia	1
	Pleuro pneumonia	1
	Thrombosis, right semi lunar valve and ruptured liver ..	1
Dog,	Verminous pneumonia	1
	Canine distemper	3
Cat,	Intestinal helminthiasis (Belascaris)	1
	Poisoning (suspect)	1
Rabbit,	Constipation	2
	Coccidiosis	3
Poultry,	Tuberculosis	3
	Ascariasis	2
	Coccidiosis	6
	Cranial concussion	1
	Cystic oviduct	1
	Deficiency disease	17
	Dessicated eggs in abdominal cavity	1
	Dessicated eggs in oviduct	1
	Dietary	12
	Diphtheria	12
	Gastro-intestinal intoxication	1
	Hemorrhagic colitis	1
	Malnutrition	1
	Multiple Sarcoma, liver, spleen, kidney	1
	Pneumonia	1
	Suffocation due to foreign body in larynx	1
	Tuberculosis	17

We have received 81 specimens from diseased animals, sent in by veterinarians and farms for diagnosis. On account of poor packing and improper methods of preparation much of this tissue reaches us in such a condition that a diagnosis cannot be made. Out of this material we have recorded the following cases:

Horse,	Acute Arthritis	1
	Equisetosis	1
	Fibro Sarcoma, face	1
	Lobar pneumonia	1
	Squamous cell carcinoma, sheath	1
Cattle,	Actinomycosis	4
	Abscess of shoulder (Streptococcic)	1
	Catarrhal enteritis	1
	Cow pox	1
	Cirrhosis of liver	1
	Pseudo leukemia	1
	Patent foramen ovale	1
	Ringworm	1
	Squamous cell carcinoma, eye	1
	Suppurative, hepatitis	1
	Vaginal abscess	1

Sheep,	Forage poisoning	2
	Hemonchus contortus	1
	Hemorrhagic septicaemia	1
	Intestinal teniasis	1
	Oesophagostoma columbiana	1
Swine,	Acute gastro-intestinal intoxication	1
	Acute interstitial nephritis	1
	Cirrhosis of liver	2
	Enteritis	1
	Hog Cholera	1
	Icterus	1
	Lobar pneumonia	1
	Melano sarcoma, face	1
	Osteoporosis	1
	Pericarditis	1
Dog,	Tuberculosis	1
	Demodex folliculorum	1
Poultry,	Avian diphtheria	1
	Dessicated eggs in abdominal cavity	1
	Exposure (young chicks)	2
	Tuberculosis	10

Respectfully submitted,

E. T. HALLMAN,

Associate Professor Animal Pathology.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF SURGERY AND CLINIC.

President Frank S. Kedzie,

Dear Mr. President:

I hereby submit my third annual report of the Department of Surgery and Clinic for the fiscal year ending June 30, 1920. The department has been fortunate in securing the services of Dr. E. K. Sales to assist in the recitation and laboratory work. Dr. Sales commenced his work in the department in October, 1919. The recitation and laboratory work has been handled entirely by Dr. Sales and myself, and the ambulatory clinic has been handled by Dr. McKercher in a very instructive and successful manner. In addition to the regular work of the department we have given instruction in Zootechnics 1, and Veterinary Science 2a, 2b, 2c; this work was handled by Dr. Sales.

The instruction work for the year together with a tabulated report of the medical, surgical and ambulatory clinics is given in the following tables.

STATE BOARD OF AGRICULTURE.

TEACHING WORK OF DEPARTMENT.

Subject.	Fall Term 1919.			Winter Term 1920.			Spring Term 1920.		
	Recitation hours per week.	Laboratory hours per week.	Number of Students.	Recitation hours per week.	Laboratory hours per week.	Number of students.	Recitation hours per week.	Laboratory hours per week.	Number of students.
Surgery 1.....	4	4	9						
Surgery 2.....							2		9
Surgery 3.....	4	2	8						
Clinic 4a.....					15	9			
Clinic 4b.....								15	8
Clinic 4c.....		15	9						
Clinic 4d.....					15	9			
Clinic 4e.....								15	8
Surgery 5.....				3		9			
Surgery 6.....				4		8			
Zootechnics 1.....				2	2	10			
Veterinary Science 2a.....	5		33						
Veterinary Science 2b.....				5		18			
Veterinary Science 2c.....							5		12
Short Course Veterinary Science.....				3		23			
Total.....	13	21	59	17	32	86	7	30	37

TABULATED REPORT OF THE MEDICAL CLINICS FOR LARGE AND SMALL ANIMALS TREATED FROM
SEPTEMBER 27, 1919, TO JUNE 19, 1920.

Name of Disease.	Horses.	Cattle.	Swine.	Sheep.	Dogs.	Cats.	Poultry.	Rabbits.	Total.
Actinomycosis.....		4							4
Azoturia.....	27								27
Abortion.....		5							5
Anemia.....		1							1
Arsenic poison.....					2				2
Acne.....	1								1
Acute gastro intestinal catarrh.....	1	3							4
Auto intoxication.....					1				1
Ascites.....									
Bronchitis.....	8	5			2				15
Coke, impaction.....	43								43
Colic, spasmodic.....	33								33
Colic, tympanic.....	4								4
Chronic gastro intestinal catarrh.....	7								7
Constipation.....					5				5
Chorea.....					3				3
Distemper.....					89	2			91
Dermatitis.....	1				2				3
Distemper vaccination.....					1				1
Eczema.....				1	1				2
Enteritis.....		1							1
Emphysema of the lungs.....	2								2
Eclampsia.....					1				1
Forage poisoning.....		8		1					9
Gastritis.....	one	polar	bear			1			2
Goiter.....		2			1				3
Helminthiasis.....	1		114	131	4	1			254
Hemorrhagic septicemia.....		1		2					3
Indigestion.....		6	1		12	1			20
Influenza.....	39								39
Impaction of rumen and intestines.....		22							22
Lymphangitis.....	7								7
Mallein test.....	3								3
Nymphomania.....	2								2
Ophthalmia, infectious.....		2							2
Pneumonia.....	1	13							14
Purpura hemorrhagica.....	5								5
Parturient paresis.....		11							11
Paralysis.....		2	1		2	one monkey		3	9
Potomac poisoning.....						2			2
Pharyngitis.....		1			1	1			3
Phthiriasis.....	5				1				6
Ring worm.....		8							8
Spasms of the diaphragm.....	2								2
Scabies.....	2				14	6			22
Stomatitis.....						1			1
Strangles.....	9								9
Tuberculin test.....		245							245
Tetanus.....	5								5
Tympanitis.....		2							2
Traumatic pericarditis.....		3							3
Tuberculosis.....		1							1
Total.....	211	346	116	135	147	13	2	3	975

TABULATED REPORT OF THE SURGICAL CLINICS FOR LARGE AND SMALL ANIMALS TREATED FROM
SEPTEMBER 27, 1919, TO JUNE 19, 1920.

Name of Disease.	Horses.	Cattle.	Swine.	Sheep.	Dogs.	Cats.	Poultry.	Rabbits.	Total.
Amputation of tail	1				19				20
Abscess	10	8	3		1	4			26
Atrophied muscles	6								6
Arthritis	6								6
Anal atresia		1							1
Ablation of the eye ball.					1				1
Bumble foot.							1		1
Blepharitis	1								1
Bruised sole.	1								1
Castration, simple.	7	4	1		8	15	one	goat	36
Castration, cryptorchid.	1								1
Confusion	14	14	1		7	3			39
Capped hock.	1								1
Choke	3	1							4
Cervicitis		2			1				3
Curb	3								3
Corns	1								1
Dystokia	1	17	8	2	2				30
Deodorizing	one	skunk							1
Dehorning		31							31
Distension of gular pouch	1								1
Dental tartar						1			1
Examination for pregnancy		2			1				3
Endometritis.		20			1				21
Ear trimming					19				19
Examination for soundness.	8	1							9
Entropia					2				2
Ectropia					1				1
Fracture of humerus					3				3
Fracture of tibia					2	1			3
Fracture of radius					2				2
Fracture of carpus					3				3
Fracture of meta tarsus						1			1
Fracture of zygomatic crest	1								1
Fistula of the withers.	4								4
Fistula of the withers.	8								8
Gonitis	1								1
Hog cholera vaccination			363						363
Hernia ventral		1	4		3				8
Hernia umbilical					1				1
Hematoma	4	8			1	3			16
Impaction of crop.							1		1
Keratitis.	3	2		1	4	1			11
Laminitis	4	1							5
Laryngeal hemiplegia	2								2
Mastitis		20							20
Milk fistula		2							2
Navicular lameness	19								19
Nail in foot	10								10
Necrosis.	1								1
Otitis					5				5
Ovariectomy			2		121	9			132
Open joint.	4								4
Parotitis	1								1
Pyometra	4	5							9
Paraphymosis	2								2
Pododermatitis	4								4
Physical examination		448							448
Periodic opthalmia	4								4
Penetrating street nail	1								1
Prolapse of vagina.		1							1

DEPARTMENT REPORTS.

87

TABULATED REPORT OF THE SURGICAL CLINICS.—Continued.

Name of Disease.	Horses.	Cattle.	Swine.	Sheep.	Dogs.	Cats.	Poultry.	Rabbits.	Total.
Quittor.....	1								1
Retained placenta.....		51							51
Rupture of ligaments.....	1								1
Ring-bone.....	5								5
Sharp and irregular teeth.....	81								81
Spavin bone.....	10								10
Sterility.....	7								7
Scratches.....	6								6
Stringhalt.....	2								2
Stricture of teat.....		6							6
Semoid lameness.....	1								1
Sprained ligaments.....	1								1
Soundness examination.....	2								2
Sprained tendon.....	7								7
Side bone.....	1								1
Shoulder lameness.....	1								1
Spavin bog.....	1								1
Trimming toe nails.....					3				3
Thrush.....	3								3
Teeth extraction.....	1								1
Tumor operable.....	13	2	1		1	1			18
Tumor inoperable.....	4	2							6
Tendinitis.....	5								5
Vaginitis.....		45							45
Wound, lacerated.....	45	8			12	3			68
Wound, incised.....	1				12				13
Wound, contused.....	12								12
Wound, puncture.....	30	9			1	1			41
Wound, gunshot.....					1				1
Total.....	383	715	383	3	238	43	2		1,770

TABULATED REPORT OF MEDICAL AND SURGICAL AMBULATORY CLINICS FOR LARGE AND SMALL
ANIMALS TREATED FROM SEPTEMBER 27, 1919, TO JUNE 19, 1920.

Name of Disease.	Horses.	Cattle.	Swine.	Sheep.	Dogs.	Cats.	Poultry.	Rabbits.	Total.
Actinomycosis.....		4							4
Abortion.....		4							4
Amputation of tail.....					10				10
Abscess.....	7	7				1			15
Atrophied muscles.....	3								3
Anemia.....		1							1
Arsenic poisoning.....					2				2
Azoturia.....	26								26
Acne.....	1								1
Arthritis.....	7								7
Acute gastro intestinal catarrh.....		3							3
Anal atresia.....		1							1
Auto intoxication.....					2				2
Ascites.....					1				1
Bronchitis.....	8	3			1				12
Balanitis.....	1								1
Bruised sole.....	1								1
Colic, impaction.....	43								43
Colic, tympanie.....	4								4
Colic, spasmodic.....	27								27
Contusions.....	11	12			4	1			28
Capped hock.....	2								2
Choke.....	2	1							3
Cervicitis.....		2							2
Castration, simple.....	7	4	1		3	13			28
Curb.....	3								3
Chronic gastro intestinal catarrh.....	6				4				6
Constipation.....					2				2
Chorea.....					2				2
Dystokia.....	1	15		2	2				20
Dermatitis.....	1								1
Distemper.....					72	1			73
Dehorning.....		18							18
Examination for pregnancy.....		2							2
Eczema.....					3				3
Endometritis.....		6							6
Ear trimming.....					9				9
Enteritis.....		1							1
Examination for soundness.....	7	1							8
Emphysema of the lungs.....	2								2
Eclampsia.....					1				1
Entropia.....					1				1
Ectropia.....					1				1
Forage poisoning.....		8		1					9
Fracture of tibia.....					1				1
Fracture of zygomatic crest.....	1								1
Fracture of radius.....					2				2
Fracture of humerus.....					2				2
Fracture of carpus.....					3				3
Fistulous withers.....	2								2
Fistula.....	7								7
Gastritis.....	one	polar	bear			1			2
Goiter.....		2			1				3
Gonitis.....	1								1
Hog cholera vaccination.....			363						363
Hernia.....		1							1
Hematoma.....	1	3			1	3			11
Hemorrhagic septicemia.....		1							1
Helminthiasis.....			111	128	3	1			246
Indigestion.....		5	1		12	1			19
Influenza.....	39								39
Impaction of the rumen and inte. fines.....		21							21
Keratitis.....	2	1			3	1			7
Laminitis.....	4	1							5
Lymphangitis.....	7								7

DEPARTMENT REPORTS.

89

TABULATED REPORT OF MEDICAL AND SURGICAL AMBULATORY CLINICS.—Continued.

Name of Disease.	Horses.	Cattle.	Swine.	Sheep.	Dogs.	Cats.	Poultry.	Rabbits.	Total
Mastitis		17							17
Milk fistula		2							2
Mallein test	3								3
Meritis					1				1
Navicular lameness	16								16
Nail in foot	9								9
Necrosis	1								1
Otitis					4				4
Ovariectomy			2		77	2			81
Ophthalmia, infectious		2							2
Open joint	3								3
Pneumonia	3	13							16
Purpura hemorrhagica	5								5
Parturient paresis		10							10
Paralysis		2	1		2	one monkey			6
Parotitis	1								1
Pyometra	4	4							8
Pharyngitis		1				1			2
Paraphymosis	2								2
Pododermatitis	4								4
Phthiriasis	3								3
Physical examination		448							448
Periodic ophthalmia	4								4
Penetrating street nail	1								1
Prolapse of vagina		1							1
Quittor	1								1
Retained placenta		42							42
Rupture of ligaments	1								1
Ring worm		8							8
Ring bone	3								3
Sharp and irregular teeth	73								73
Spavin bone	10								10
Sterility		2							2
Spasms of the diaphragm	2								2
Scratches	6								6
Scabies					9	6			15
Stringhalt	1								1
Stricture of test		5							5
Sesamoid lameness	1								1
Sprained ligaments	1								1
Soundness examination	2								2
Sprained tendon	7								7
Strangles	8								8
Shoulder lameness	1								1
Spavin Bog	1								1
Tuberculin test		251							251
Tetanus	5								5
Thrush	3								3
Teeth extraction	1								1
Tumor operable	9	1							10
Tumor inoperable	1								1
Tympanites		1							1
Traumatic pericarditis		2							2
Tuberculosis		1							1
Tendinitis	5								5
Vaginitis		45							45
Wound, incised	1				11				12
Wound, contused	12								12
Wound, lacerated	38	7			10	3			58
Wound, puncture	30	6	1			1			38
Wound, gunshot					1				1
Total	416	999	483	3	263	36			2,200

A tabulated report of the clinics for the past school year shows that we have had a very substantial increase over that of 1918-1919. Last year the total number of medical and surgical cases treated was 1860, this year the total number was 2745 an increase of 885 cases over last year. The tabulated report shows that 2200 cases were treated in the ambulatory clinic during the past school year. This I consider one of the most valuable parts of our clinic, as here the student actually comes in contact with the work just as he will find it in private life.

Respectfully submitted,

JOHN P. HUTTON,

Associate Prof. Surgery & Clinic.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF BACTERIOLOGY.

President F. S. Kedzie:

Dear Sir:

It is gratifying to be able to report that our department has fully re-established its position of strength held before the war. Our staff is complete and highly qualified. Dr. H. J. Stafseth is on leave until February 1921 in the service of the Norwegian Government. Research Associate, I. F. Huddleson has charge of his classes in pathogenic bacteriology and immunology. Research Associate, G. L. A. Ruehle will have charge of the class work in dairy bacteriology formerly conducted by Research Associate L. H. Cooledge. Both Mr. Huddleson and Mr. Ruehle bring a high degree of training, experience and enthusiasm to their work. Associate Professor Fabian and Assistant Professor Mallman have charge of the students' laboratory. The former has successfully given a course in the bacteriology of the apiary to advanced students in beekeeping and the latter has initiated in a very satisfactory manner the civil engineers in a course in sanitary bacteriology. Professor Fabian will give a course in industrial hygiene to the chemical engineers next year. He has the fundamental training for this work with the added advantage of some considerable practical experience in the department of hygiene of the Ford Motor Works.

The number of students enrolled for the year in courses in bacteriology and hygiene is considerably below the pre-war figures. The tabulation according to terms follows:

Summer Term 1919.

Bacteriology, 1a, b, c.....	By Ward Giltner.....	13	students
Bacteriology 2.....	By W. L. Mallman.....	11	"
Bacteriology 3.....	By F. W. Fabian.....	8	"
Bacteriology 4.....	By F. W. Fabian.....	3	"
Bacteriology 13.....	By Ward Giltner.....	17	"
Bacteriology 19.....	By H. J. Stafseth.....	5	"
Bacteriology 23.....	By W. L. Mallman.....	5	"
Bacteriology 105.....	By H. J. Stafseth.....	1	"

Summer Term 1919 (Second)

Bacteriology 1a, b, c.....	By F. W. Fabian.....	9 students
Bacteriology 2.....	By W. L. Mallman.....	10 "
Bacteriology 4.....	By W. L. Mallman.....	7 "
Bacteriology 13.....	By Ward Giltner.....	12 "
Bacteriology 14.....	By Ward Giltner.....	1 "
Bacteriology 103.....	By L. H. Cooledge.....	1 "
Bacteriology 105.....	By H. J. Stafseth.....	2 "

Fall Term 1919.

Bacteriology 1.....	By Ward Giltner.....	71 students
Bacteriology 1a.....	By Ward Giltner.....	145 "
Bacteriology 2.....	By W. L. Mallman.....	36 "
Bacteriology 3.....	By F. W. Fabian.....	22 "
Bacteriology 13.....	By Ward Giltner.....	8 "
Bacteriology 103.....	By L. H. Cooledge.....	2 "

Winter Term 1920.

Bacteriology 1b.....	By Ward Giltner.....	130 students
Bacteriology 2.....	By W. L. Mallman.....	62 "
Bacteriology 2.....	By F. W. Fabian.....	27 "
Bacteriology 3.....	By F. W. Fabian.....	21 "
Bacteriology 4.....	By W. L. Mallman.....	13 "
Bacteriology 103.....	By L. H. Cooledge.....	2 "

Spring Term 1920.

Bacteriology 1c.....	By Ward Giltner.....	99 students
Bacteriology 2.....	By F. W. Fabian.....	8 "
Bacteriology 3.....	By W. L. Mallman.....	11 "
Bacteriology 4.....	By F. W. Fabian.....	8 "
Bacteriology 13.....	By Ward Giltner.....	1 "
Bacteriology 14.....	By Ward Giltner.....	12 "
Bacteriology 15.....	By Ward Giltner.....	4 "
Bacteriology 17.....	By G. L. A. Ruehle.....	9 "
Bacteriology 19.....	By I. F. Huddleson.....	27 "
Bacteriology 23.....	By W. L. Mallman.....	33 "
Bacteriology 103.....	By L. H. Cooledge.....	1 "

Mr. Robert Tweed completed his work for the M. S. degree during the spring term. His thesis is entitled: "A Study of the Effect of the Milk Upon the Bacterial Flora of the Intestinal Tract." The work was done under the direction of Res. Assoc., L. H. Cooledge. Mr. Tweed will be on our staff next year as Research Assistant and Instructor.

One of the graduate assistantships allotted to this department has been filled by the appointment of Otto Friedeman, B. S. of the Oklahoma A. and M. College, the other assistantship remains open as yet. One of the evils of the war is reflected in the lessened enthusiasm on the part of our university and college graduates for the pursuit of graduate studies. We should lose no opportunity to strengthen our graduate courses with the view to the firm establishment of a strong and inspiring graduate school, not only for the good it will do *per se* but for the effect it will have on our undergraduate work.

The student health situation has not improved markedly during the past year. There has been some progress in the matter of providing a dispensary service, but this has been done at the expense of much val-

nable hospital bed space. As a matter of fact, we have fewer available beds than at any time in the past ten years. This phase of student health service can be made effective only when each student is brought into a proper relation to the whole service by means of a mutual understanding between the College on the one hand and the student on the other, in which the former undertakes to guard the health of the latter collectively and individually, and the latter acknowledges his obligations by the payment of a fee and by submitting to the regulations prescribed by the properly constituted authority. Miss Ethel Dietz, the head nurse, is entitled to much commendation for her efforts under adverse circumstances. She has prepared at my request the following tabulations of the results of the dispensary service:

Number of students receiving dressings.....	684
Number of students receiving treatments.....	975
Number of students receiving examinations.....	156
Number of students receiving medicine.....	336

Total number of students.....	2,151
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The average number of students visiting dispensary each school day was eleven.

In addition there have been treated in the hospitals the following cases during the year:

<i>Diseases</i>	<i>No. of cases</i>
Acute Indigestion	1
Asthma	1
Bronchitis	2
Heart Lesion	1
Hemorrhage of Lungs.....	1
Influenza	41 (1 died)
Injury and Infection.....	18 (1 died, taken to Lansing Hosp.)
Jaundice	4
La Grippe	2
Lumbago	1
Measles	28
Nervous Breakdown	4
Observation	18
Pleurisy	2 (1 taken to Lansing Hosp.)
Pneumonia	5 (1 died)
Scarlet Fever	4
Severe Cold	15
Small Pox	7
Tonsilitis	19
Tuberculosis	1

Financial Report

Nurses	\$2,903.68
Sundry items	2,820.00
<hr/>	
Total expenditures	\$5,723.68
Hospital receipts	1,257.31
<hr/>	
Deficit	\$4,466.37

The expense of administering the hospitals aside from the regular salaries of nurses and the health officer is given above.

Mr. Mallman has examined the water of the college swimming pool twice a week while it has been in use. Whenever the water showed *Bacillus coli* in 1 cc. of water, chloride of lime was added at the rate of 16 pounds per million gallons of water.

Various standards of purity were tried out for the swimming pool and finally *Bacillus coli* in 1 cc. was used as indicating pollution. No definite standard for number of bacteria per cubic centimeter has been adopted, as yet, however, counts in excess of 1000 per cc. when no *Bacillus coli* appeared is regarded as *unsafe*.

Mr. Ruehle and Mr. Huddleson have been of great assistance in the conduct of the hospitals, the former as a graduate pharmacist and the latter in connection with laboratory diagnosis and the preparation of vaccines as indicated in the following paragraph.

During the spring, there occurred among the student body and in the community what appeared to be an epidemic of acute throat and ear infections. A bacteriological examination of swabs taken from a large number of the cases revealed either *Streptococcus hemolyticus* or *Streptococcus viridans* as being the predominating organism. Autogenous vaccines were prepared for about eighteen of the cases of which about 50 per cent gave favorable results.

Miss Ruby Stutsman is entitled to much credit for her able conduct of all the office work especially that relating to hospital activities. I believe that Dr. O. H. Bruegel, college health officer, is worthy of our hearty thanks for his untiring efforts under the handicap of a part time position. Only a full time college employee can do full justice to the work.

My sincere appreciation is hereby expressed for the ever willing and efficient cooperation on the part of every member of the departmental staff during the year's work and for your own advice and assistance.

Respectfully,

WARD GILTNER,

Professor of Bacteriology.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF BOTANY.

President F. S. Kedzie, College.

Dear President Kedzie: Herewith I present you my report for the fiscal year just closed.

The staff of the Botanical department remained essentially the same as for the preceding fiscal year, except that Mr. C. W. Bennett was promoted to full time instructor and Mr. L. E. Tisdale was appointed half-time graduate assistant in Mr. Bennett's place. It was impossible to fill the other half-time graduate assistantship assigned to this department, owing to the small number of men in this country entering graduate work in botany.

The enrollment of students in this department continued to show the effect of war conditions, particularly for the courses offered to upper classmen. As a consequence it was not considered advisable to attempt to bring the teaching force back to the number employed before the outbreak of the war. The number of students in under-graduate courses ranged between 250 and a little over 300.

Majoring in botany, there were five graduate students, one of whom received his M. S. degree last month, another similar degree being granted to a student who had completed his work, with the exception of finishing his thesis, last summer.

The department has been represented at various scientific conferences and at the meetings of various scientific societies during the year, among these being the meetings of the A. A. A. S. and affiliated societies at St. Louis, Missouri, and the Michigan Academy of Science at Ann Arbor where Dr. Hibbard was Chairman of the Section of Botany.

During the month of August, 1919, in cooperation with the Michigan Geological and Biological Survey, Professor Darlington and I botanized intensively in Gogebie county, a portion of the State that has been practically untouched by botanists. Many plants new to the State were discovered, while the known range within the State of many other plants was greatly extended. Some fungi were discovered that were new to science. In June of this year, Professor Darlington spent two weeks in the vicinity of Ironwood and the Lake Superior shore north of that city and a short time in Baraga county, attempting to get the spring flora of these regions. The collections resulting from this cooperative work are deposited in the herbarium of this College and have greatly increased the value of this already very valuable collection. It is the intention of Professor Darlington and myself to prepare for publication by the College, a Flora of Michigan, somewhat comparable in purpose to Professor Barrows' book on birds.

In the attempt to further the botanical interest of students, the department has cooperated closely with the Botanical Seminar. Under the auspices of the latter, Dr. Henry Kraemer, Dean of the College of Pharmacy of the University of Michigan, was invited to the College and gave a public address entitled "The Growing of Medicinal Plants." The Botan-

ical Seminar also in cooperation with this department held its annual spring foray on June 5th, a botanizing trip in which over 60 participated. Transportation was furnished by autos and by the army truck.

It is very much to be regretted that the high cost of building materials and labor has prevented the construction of additional greenhouses, as the lack of sufficient greenhouse space is a very great handicap in the work of the department.

This marks the close of the fiftieth year since Professor Emeritus W. J. Beal entered the service of the College. I am glad indeed to bear tribute to the breadth and depth of the foundation which Dr. Beal in his zeal so well laid.

Respectfully submitted,

E. A. BESSEY,

Professor of Botany.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

President F. S. Kedzie, College.

Dear Sir: I have the honor to submit the following report on the work of the Department of Chemistry for the year ending June 30, 1920.

The teaching staff for the year was as follows:

- A. J. Clark, Professor.
- R. C. Huston, Associate Professor.
- H. S. Reed, Associate Professor.
- B. E. Hartsuch, Associate Professor.
- D. T. Ewing, Assistant Professor.
- H. L. Publow, Assistant Professor.
- P. S. Brundage, Assistant Professor.
- C. D. Ball, Instructor.
- E. F. Eldridge, Instructor.
- H. C. Lange, Instructor.
- H. A. Iddles, Instructor.
- B. E. French, Instructor.
- H. D. Lightbody, Instructor.
- C. J. Overmyer, Instructor.

The increase in number of students taking work in the department caused considerable crowding; but with the fine cooperation of all members of the staff, the work of the year was handled very satisfactorily.

Thirty-three courses have been offered during the year. The number of students enrolled in the department during the year is as follows:

Summer Session, 1919.....	137
Fall Term, 1919.....	544
Winter Term, 1920.....	704
Spring Term, 1920.....	585

1970

Respectfully submitted,

ARTHUR J. CLARK,

Professor of Chemistry.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF ENGLISH AND MODERN LANGUAGES.

President Frank S. Kedzie, College.

Dear President Kedzie: I have the honor to submit to you a report on the work of the Department of English and Modern Languages for the year ending June 30, 1920.

The number of students enrolled in the department for the year, exclusive of short courses and of preparatory work given to ex-soldiers and sailors, was as follows:

	English.	French.	Total.
Summer term, 1919.....	63	8	71
Fall term, 1919.....	752	55	807
Winter term, 1920.....	901	65	966
Spring term, 1920.....	885	38	923
Total.....	2,601	166	2,767

The following persons constituted the teaching staff for the year:

W. W. Johnston, Professor of English and Modern Languages.

Egbert S. King, Associate Professor of Public Speaking.

C. Buren Mitchell, Associate Professor of Public Speaking.

Ray B. Weaver, Assistant Professor of English.

Norma G. Roseboom, Assistant Professor of English.

Leo C. Hughes, Assistant Professor of French (on leave).

Omar M. Lebel, Assistant Professor of French.

James B. Hasselman, Instructor in English (also Director of Publications).

Albert H. Nelson, Instructor in English.

Levette J. Davidson, Instructor in English.

Myra E. Retz, Instructor in French.

Of those named, Mr. Leo C. Hughes has been on leave of absence for the year. His leave enabled him to spend several months in France familiarizing himself with spoken French. Since his absence necessitated the employment of an additional instructor in French for

the year, I chose Miss Myra E. Retz, a graduate of the University of Chicago, who had had several years' successful experience as a teacher of French.

Another member of the staff, Mr. James B. Hasselman, has taught for us but two hours a week. When, more than a year ago, Mr. Hasselman was elected by the Board to the position of Director of Publications, an arrangement was made by which he would retain for the first year his connection with the Department of English in order that he might continue to give the course in Writing for the Press. His services with the department have been highly satisfactory, and I regret that the growing responsibilities and duties of his new position make it advisable that he sever his connection with the Department of English.

Two of the instructors of the department have been with us only since September. They are Mr. Nelson and Mr. Davidson. Mr. Nelson has the degree of bachelor of arts and that of master of arts from Wabash College. As a member of the American Expeditionary Force he spent four months in the University of Paris after the signing of the armistice. His experience as a teacher of English was gained in the Agricultural and Mechanical College of Oklahoma, in which institution he served as instructor in English for three years. Mr. Davidson has the degree of bachelor of arts from Eureka College and that of master of arts from both the University of Illinois and Harvard University. He was instructor in English in Northwestern University during the year 1917-'18, and, after receiving his discharge from the army, served as instructor in English in Pennsylvania State College from February to June of last year.

Both Mr. Nelson and Mr. Davidson have rendered efficient service during the year. They are men of character, are well trained in English, and have carried on their work with intelligence and enthusiasm. I am happy to have been able to add them to the staff of the English department at a time when it is becoming increasingly difficult to secure capable men for work in English.

Since I made my last report one member of the department has been removed by death. Mrs. Robson taught to the end of the spring term of last year, and several even of her close friends were unaware that she did so under the handicap of physical weakness and pain. It was with deep sorrow that, in the summer of 1919, all who knew Mrs. Robson learned that she was ill and could not recover. She was a woman of superior intelligence and of the finest character and personality.

Besides teaching several hundred students each term, the department carries on several extra-curriculum activities. It has been my custom to include in my annual report a brief statement of the essential facts in regard to some of these activities, and, in particular, to report to you the names of students who have won honors in our contests. Accordingly I include herewith similar information relating to the present year.

In our tristate debate we were successful this year, as for three years previous. We won over Iowa State College by a two-to-one decision and over Purdue University by a unanimous decision. The question debated was: "Resolved, That Labor should have a share in the management of industry through representatives of its own choosing." Our negative team, which defeated Iowa, was made up of B. W. Bellinger, D. V. Steere, and C. J. McLean. The affirmative team, which defeated Purdue, con-

sisted originally of A. L. Peterson, H. E. Hemans, and S. M. Powell; but the sickness of Mr. Hemans necessitated that his place be taken by Mr. L. F. Keely, the alternate. The alternate of the negative team was H. H. Every. It is a high honor to the men named above to have represented their alma mater in debate. It has been my experience, not only in Michigan Agricultural College, but in the two other institutions in which I have taught, that students who represent their college in debate will later be found to be among the most able and most influential of its graduates. Many a student has said that in preparing for an intercollegiate debate he has received training in investigation, in analysis, and in rigorous thinking which has meant more to him than any regular course which he has taken during his college career. He receives, likewise, the discipline which comes from actual oral presentation of his argument before judges and in the presence of wary and skillful opponents. Such discipline is frequently found to be invaluable as preparation for life.

The George E. Lawson Essay Contest was won by Mr. Fred Henshaw. Mr. Henshaw's essay was entitled *Jazz and Bolshevism*. It discussed in an informal manner the spirit which underlies "bolshevism" in politics "jazz" in music, "free verse" in poetry, "cubism" in art, and other manifestations of license and revolt. This year the maximum length allowed for essays was raised to twenty-five hundred words, since it was felt that the limitation heretofore in effect had sometimes hampered the contestants and led to over-condensation, with a resulting stiffness of style.

The Eunomian-Holead prize of \$25.00, offered annually for the best story or poem of the year, was won by Priscilla Proseus. Her manuscript was a story entitled *The Tale of Elizabeth Ann*. The second prize was won by Margaret Himmelein. Her manuscript was a story entitled *A Man of Title*. The third prize was awarded to R. S. Clark for a poem, *The Rime of the Rustic Plowman*. Mr. Clark has the distinction of having won first place in this contest in two former years.

Two other extra-curriculum activities supervised by members of the department were the commencement pageant and the commencement play. This year's pageant was attended by so many hundreds of people and was so well reported in the press that without doubt all members of the Board are somewhat familiar with it. Credit for the planning of this pageant and for the general supervision of it in all its various features should be given to Mrs. Roseboom. Much credit is also due to those members of various departments of the college who were in charge of the different phases of the pageant, and to the several hundred students who took part and to whose loyal cooperation and support the ultimate success of the project was due.

The performance of the commencement play was unfortunately cut short immediately after the first scene by rain. The play selected was *The Comedy of Errors*, and the place the usual one—the Forest of Arden. The audience was the largest which has ever assembled to see one of our commencement plays. The opening scene was acted with a spirit which showed that under the direction of Professor King the Dramatic Club was prepared to give a really notable performance of the comedy.

To all members of the department I wish to express my sincerest appreciation of the interest which they have shown in the students under

them and in the various curriculum and extra-curriculum activities of the department.

To you, Mr. President, and to the members of the Board, I express my hearty thanks for your support and encouragement. The revised salary schedule which you adopted enabled me to hold the department together. Without it I should have lost at least one-half of my men.

Respectfully submitted,

W. W. JOHNSTON,

Professor of English and Modern Languages.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE DEPARTMENT OF MATHEMATICS.

President F. S. Kedzie, College:

Dear Sir: I have the honor to submit for your consideration the following report on the work of the Department of Mathematics for the year ending June 30, 1920.

During the year the teaching staff of the department was as follows:

L. C. Plant, Professor.

L. C. Emmons, Associate Professor.

G. G. Specker, S. E. Crowe, V. G. Grove, Assistant Professors.

Wm. M. Wible, C. T. Bumer, Eugenia Armstrong, Instructors.

In September, 1919, Assistant Professor M. F. Johnson resigned to accept a position in the University of Michigan. His successor, Vernon G. Grove, who was a member of the mathematical staff of Cornell University, did not come into residence until January, 1920. The department was able to secure Miss Eugenia Armstrong, class of '17, to teach mathematics for the fall term only.

Mr. C. T. Bumer, who was professor of mathematics in Salem College, took up his duties in the department at the beginning of the winter term.

Whatever success has come to the department no small amount is due to Associate Professor Emmons and Assistant Professors Specker and Crowe. These men are always alert to the needs of the department and give freely of their time. I take this occasion to express to the new men, Mr. Grove and Mr. Bumer, my appreciation of their adaptability and efficiency.

During the year the staff has conducted lectures bi-weekly on advanced work in mathematics. This work not only increased the mathematical equipment of the staff, but also encouraged a sympathetic student attitude.

The total number of students taking mathematics during the year was 1,748, divided among the different terms as follows: Fall, 326; winter, 576; spring, 473; summer, 176. The total number of class periods for the year was 409, divided among the different terms as follows: Fall, 105; winter, 117; spring, 112; summer, 75.

Respectfully submitted,

L. C. PLANT,

Professor of Mathematics.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY.

To the President:

Sir: I have the honor to submit the following report of the Department of Zoology and Physiology for the year ending June 30, 1920.

Changes in the curriculum lessened somewhat the teaching work of the department during the year and this, together with the somewhat smaller attendance due to the recent war conditions made the year an abnormal one. The principal change in the teaching force was the loss of Assistant Professor Frederick A. Burt, who resigned on December 31, 1919, in order to accept a similar position in the Agricultural College of Mississippi. Mr. Burt came to us as an instructor in September, 1909, and was made Assistant Professor of Geology in June, 1914. It is a pleasure to bear witness to his long and faithful service and his sterling worth as a teacher and associate. The department has never had a more conscientious and indefatigable worker and his withdrawal is a distinct loss to the department and the College. Fortunately Mr. Stanard G. Bergquist, who had been absent on leave for two years in government service with the 20th Engineers in France, returned to us in September and was able to carry on the work which Professor Burt left, so that it has not been necessary thus far to employ another man for the work in geology. This work, however, is increasing yearly in importance and eventually another instructor will have to be added.

The dropping of the sophomore zoology in the Home Economics course and the transfer of the physiology in this course from the freshman to the junior year has unbalanced the teaching work temporarily and in my opinion is not likely to result in any permanent benefit to either department. Some change in curriculum of course is unavoidable but changes involving so many students and so much teaching time are unfortunate to say the least.

In addition to the teaching work of the department two publications of importance have been undertaken, one being a Key to the Vertebrate Animals (except birds) of the State, which Professor Conger has prepared for the use of our own classes and for those of our students (and others interested) who are to become teachers in the public schools of the State. This bulletin is now in type and will be ready for distribution before the end of July. It forms a pamphlet of seventy-five pages, is without illustrations, but, as its title implies, is a laboratory guide which will enable any capable student or intelligent school boy to identify fishes, reptiles, amphibians or mammals which he may have in hand, dead or alive. It will be sold to students and others practically at cost and is published jointly by the Zoological department and the Department of Agricultural Education. For several years Professor Conger has been collecting material for a descriptive bulletin on the Mammals of the State with particular reference to the fur-bearing species and others which are of marked economic importance. But for the scarcity of printing paper this bulletin doubtless would have been in the printer's

hands before now. It is hoped it may be ready for distribution during the coming winter.

The head of the department as well as Assistant Professor Conger and Instructor Stack have given occasional talks or addresses before several associations and schools during the year and the usual amount of correspondence has been carried on in the way of extending the knowledge of natural history to the farmers and citizens in general. The department cooperates with the State Game and Fish Warden, identifying mutilated and doubtful specimens of supposed noxious animals submitted for bounties, and exchanging information as to the habits and distribution of animals, both native and introduced.

Probably it is proper to mention here that for many years past the head of the department has served as consulting Zoologist of the State Geological and Biological Survey and as Secretary of the Non-Game License Commission, which issues permits to those desiring to collect specimens of non-game birds for scientific purposes. He is also the Michigan member of the Bird Lore "Advisory Council," Bird Lore being the bi-monthly journal of the National Association of Audubon Societies whose members are privileged to consult members of the Advisory Council in regard to any problems of bird life which present themselves.

MUSEUM.

There is little to record with regard to the museum and its work during the past year. Its collections have been cared for in the usual way and seem to have had an increased attraction, as shown by the large number of visitors and the constant use made of its collection by the students. Some unimportant changes in arrangement have been carried out and considerable work in cataloging and arranging the extensive bird's-egg collection has been done. The employment of a competent taxidermist, who might also serve as assistant curator, is one of the great needs of the department and my suggestion that such an addition be made may now be considered perennial.

Respectfully submitted,

WALTER B. BARROWS.

Professor of Zoology and Curator of the General Museum.
East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

President F. S. Kedzie:

Dear Sir: Following is a brief report of the work of the Department of Entomology for the year ending June 30, 1920.

During the year the following courses were given by the department:

Summer term 1919. First half:

Entomology	I	Introduction to Study of Insects.
Entomology	II	Fruit Insects.
Entomology	III	Field Crop Insects.
Entomology	V	Coccidae and applied systematic work.
Summer school for teachers (Smith Hughes) 4 lectures.		

Summer Term 1919. Second half:

Entomology	V	Study of Coccidae.
Entomology	XII	Systematic.

Fall Term:

Entomology	III	Field Crop Insects.
Entomology	V	Applied Systematic Work.
Entomology	VIII	Parasitology for Veterinary students.
Entomology	Xb	Apiculture (option).
Entomology	IXa	Apiculture (elective).

Winter Term:

Entomology	IV	Forest Insects.
Entomology	V	Applied Systematic Entomology.
Entomology	XII	Systematic Entomology.
Entomology	Xc	Apiculture (option).

Short Courses:

- Two weeks short course in Apiculture.
- Two weeks short course in Garden Insects.
- Four weeks short course for Poultry students.
- Eight weeks short course in Horticulture, short course.
- Eight weeks short course in 16 weeks Gen. Agr. 2nd year.
- Eight weeks short course, 8 weeks Gen. Agr. 2nd year.
- Eight weeks short course in Apiculture for Hort. students.

Spring Term:

Entomology	I	Introductory Entomology.
Entomology	II	Fruit Insects.
Entomology	V	Applied Entomology.
Entomology	IXb	Apiculture (elective).
Entomology	Xa	Apiculture (option).
Entomology	Xd	Apiculture (option).

In addition to the above, Entomology 100, a graduate course, was given throughout the year.

On July 1, 1919, Mr. Russell Hain commenced work as Extension Specialist in insect control, taking the place made vacant by the resignation of Mr. Don B. Whelan. His report to the Division of Extension is found elsewhere in this volume.

Miss Oneta Abbott has been appointed to take the place of Miss Ruth McKim and Mr. J. L. L. Frank, a recent graduate from Cornell, has been appointed as half-time graduate student assistant to assist Doctor Chandler in his work in parasitology, his appointment to take effect on Sept. 1 next. Mr. Edwin Ewell still continues doing extension work in apiculture and his report to the Division of Extension will be found elsewhere in this volume.

The department now possesses a small but well ordered apiary sufficient for purposes of instruction, together with a shop fairly equipped for practical work in beekeeping in a moderate way. Equipment for a large commercial apiary would mean merely the installation of more labor-saving machinery, mostly of a cumbersome nature.

The report of the State Inspector of Apiaries, whose activities find a home in this department, will be found elsewhere.

The discovery in eastern North America of the destructive European corn-borer led to a trip during August, 1919, to infested fields in Massachusetts and New York where the actual destruction of fields of corn was witnessed by the writer and some acquaintance with its field appearance was gained in the hope that when the insect appears in our State we may be able to start restricting its spread intelligently. We have also carried on a search in regions where the pest seemed most likely to become established; thus far, fortunately, without success.

Respectfully submitted,

R. H. PETTIT,

Professor of Entomology.

East Lansing, Mich., June 30, 1920.

REPORT OF THE STATE INSPECTOR OF APIARIES.

To the Honorable State Board of Agriculture:

I beg to submit the following as the seventh annual report of the State Inspector of Apiaries:

The following is a summary of the year's work:

Number of Apiaries visited.....	1,027
Number of colonies inspected.....	10,906
Number of colonies affected with foul brood.....	1,627
Number of diseased colonies treated or destroyed.....	47
Number of illegal hives found.....	427
Number of arrests for keeping bees in illegal hives or exposing diseased combs.....	26
Number of beekeepers meetings attended.....	78

The policy of inspection work was decidedly changed at the beginning of the present fiscal year by the employment of seventeen local deputies. The plan is to have a number of practical beekeepers in various parts of the State act as deputies in their own or adjoining counties. Thus far the plan has worked out very satisfactorily. It effects a decided saving in the cost of inspection and at the same time gives the beekeepers quicker service than if the work were handled by deputies sent out directly from this office. As time goes on more men will be trained and used in local work.

In October, 1919, there was started a series of Two Day Beekeepers' Schools for the purpose of educating the beekeepers regarding foul brood, its treatment and better methods of beekeeping in general. During

the winter of 1919 and 1920 schools were held in thirty-nine counties in cooperation with the county agents and with Mr. Edwin Ewell, Extension Specialists in Beekeeping. A regular program was made up covering the work of two days and the same program was given in each county. Only those matters were discussed which were considered fundamental in beekeeping practice and applicable to beekeeping throughout the State. It is felt that a great deal of good was done. At the present time there are on file applications for a large number of schools to be held during the coming winter. It is felt that the educational work which is carried on is fully as important and often of greater value than actual inspection work. However, the one would not be complete without the other.

At the beginning of the present fiscal year all deputies were instructed to enforce the law relative to illegal hives. Large placards were sent out two years before giving the beekeepers instructions relative to the law and warning them that the law would be enforced after July first 1919. As a result many hundreds and probably thousands of colonies were transferred from the old boxes and log gums into modern hives. This marks a decided forward step in Michigan beekeeping.

The last winter is considered by the older beekeepers as the most severe from a beekeeping standpoint that we have had in the last thirty-five years. The southern half of the lower peninsula suffered more than the northern part of the State. Thousands of beekeepers lost all of their bees. It has been estimated that 90% of the bees belonging to the so-called "farmer beekeepers" died. The professional beekeepers did not suffer nearly so great a loss, due doubtless to the better care which they gave their colonies. Possibly the State as a whole lost nearly 50% of its bees. This spring has been quite favorable for the rapid building up of colonies and by fall a large part of the losses will be made up. However, probably several thousand persons have given up beekeeping. This is a gain for the industry as it leaves the bees in the hands of persons who are interested in the bees and who will give them the care they require.

The following is the financial statement for the fiscal year ending June 30, 1920:

Salaries of State Inspector and Deputies.....	\$6,047.60
Stenographer	300.00
Traveling Expenses.....	2,893.57
Stationery, postage, printing, etc.....	425.85
Equipment and furniture.....	145.28
Supplies	26.66
Returned to the State.....	321.04
<hr/>	
Total amount appropriated.....	\$10,166.00

During the year the following queen breeders' apiaries have been inspected and have been given certificates for the sale of queens:

D. A. Davis, Birmingham.

M. H. Hunt, Redford.

J. H. Harghey, Berrien Springs.

E. E. Mott, Glenwood.

W. Z. Ruggles, Three Rivers.
 A. G. Woodman Co., Grand Rapids.
 John A. Stevens, Mio.

Respectfully submitted,

B. F. KINDIG,
 State Apiary Inspector.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF ECONOMICS.

To the President:

The following is the report of the Department of Economics for the year 1919-20.

The total enrollments for the year equalled 647, distributed as follows:

By terms—Fall, 230; winter, 273; spring, 151; summer, 21.

By classes—Senior and junior, 231; sophomore, 226; freshman, 217.

By subjects—Economics, 614; Sociology, 60.

The total number of hours taught during the year by members of the department equalled 1179, divided as follows:

By terms—Autumn, 312; winter, 312; spring, 275; summer, 180.

By subjects—Economics, 1004; Sociology, 175.

By teacher—Mr. Hedrick, students, 309; hours 470.

Mr. Dunford, students, 431; hours, 446.

Mr. Tennant, students, 88; hours, 72.

The departmental staff has been increased during the year by the addition of Mr. Hale Tennant who brings a wide familiarity with marketing problems and cooperative organizations among farmers. During the year the college duties of the department have been increased by the conferring of the position of absence officer upon Mr. Dunford thus materially making exactions upon his time. Mr. Hedrick in collaboration with Prof. Anderson of the Dairy department published a bulletin entitled "The Detroit Commission Plan of City Milk Administration" which it is hoped will be the first of a series of studies into the economic aspects of certain farm undertakings.

Very respectfully submitted,

WILBUR O. HEDRICK,

East Lansing, Mich., June 30, 1920.

Professor of Economics.

REPORT OF THE DEPARTMENT OF HISTORY AND POLITICAL SCIENCE.

President F. S. Kedzie, College.

Dear President Kedzie: In accord with the practice of former years, I am presenting to you a brief report for the Department of History and Political Science. For the first time since the United States entered the war, this department has found itself back to normal work. Each year, for some time, has demanded of the department special activities in some way relating to the war. For the year 1919-20, we have devoted ourselves to the established courses of the department.

There is little in the way of detail that needs comment in this report. The election of our courses by the students has been large, a fact that may be attributed to the fact that interest in matters of this kind has been stimulated by the world experiences of the recent years.

For the first time the department gave courses in History and Political Science to freshman engineers. These courses came during the spring term. This, with the large elections of the winter term, made it necessary to engage an additional teacher for two terms. Fortunately we were able to secure the services of Miss Dorothy Brown for the remainder of the year. Miss Brown's broad training and exceptional experience in teaching and world travel, made her acquisition of inestimable value to the department. Would that one of her ability and experience might be found for the years to come.

Suffrage has aroused interest in government. During the spring term more than one hundred juniors and seniors elected a course devoted to elections, suffrage and political party organization. This same subject matter brings many calls from the outside for assistance from this department. Mrs. Mary Hendrick, Assistant Professor in the department, in addition to giving a series of lectures before a Woman's Club in Lansing during the past year, has gone out to various localities in response to requests of Women's clubs, to discuss matters of citizenship and political organization. Many requests of this nature have been denied by the department because of the inability of the present force to perform the service along with the classroom work of the College. These calls are an indication of the healthy interest in public affairs prevailing over the State, and the possibilities of service which might be performed in this direction, providing adequate means could be found for handling the work.

Finally, I want again to record the proper recognition of the very high class order of service performed by Mrs. Hendrick as class instructor, and in her work throughout the State in public lectures. Special mention should be made of her service in the organization of a Woman's Conference here at the College in June, in cooperation with Dean Edmonds.

Respectfully submitted,

E. H. RYDER,

Professor of History and Political Science.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF PHYSICS.

President F. S. Kedzie, College.

Dear Sir: The following is a brief report of the Department of Physics for the school year ending June 30, 1920.

Since the work of both summer terms was very heavy, Mr. P. G. Andres, Assistant Professor of Electrical Engineering, was loaned to this department by the Department of Electrical Engineering, to assist us in teaching Engineering Physics. Prof. Andres also assisted us part time during the preceding term due to the resignation of Mr. E. A. Armstrong, Assistant Professor of Physics, who left the College March 30, 1919.

Mr. Edwin Morrison who had been Head of the Physics department at Earlham College, Richmond, Indiana, for thirteen years, was appointed Assistant Professor of Physics, Sept. 1, 1919, to succeed Assistant Professor Armstrong, resigned. Miss S. Elizabeth Morrison, a graduate of Earlham College, was hired, Jan. 1, 1920, as Laboratory Assistant and Clerk.

On account of the increase in attendance during the past year, our three laboratories in the basement of the forestry building have not afforded sufficient space for the proper handling of our laboratory classes during the day, and we have found it necessary to hold classes nearly every night of the week in two of these laboratories. Next year, however, a more serious problem along this line will confront us. An increase in enrollment means a larger number of laboratory sections; hence adequate facilities must be provided for them, and it will be only a matter of a short time before the department must seek larger quarters.

At the beginning of the spring term just ended, about thirty students applied for Physics 4c which is scheduled to be given during the spring term. On account of insufficient room this course was not given this year.

The personnel of the department consisted of the following:

Charles W. Chapman, Professor of Physics.

William E. Laycock, Associate Professor of Physics.

Edwin Morrison, Assistant Professor of Physics.

S. Elizabeth Morrison, Laboratory Assistant and Clerk.

Ralph M. Harford, College photographer.

The tabulation below shows the courses given each term throughout the year, and the number of students enrolled.

Respectfully submitted,

CHAS. W. CHAPMAN,

Professor of Physics.

East Lansing, Mich., June 30, 1920.

FIRST SUMMER TERM 1919.

Course.	No. Hours per Week.			Enroll- ment.
	Lect.	Quiz.	Lab.	
Physics 1d	2	2	2	9
Physics 1e	2	2	2	3
Physics d2	2	2	2	4
Physics 2e	2	2	2	2
Physics 2f	2	2	2	29
Physics 4b	2	0	2	9
Prep. Physics	2	3	2	19
Total	14	13	14	75

SECOND SUMMER TERM 1919.

Physics 2e	2	2	2	7
Physics 2f	2	2	2	3
Prep. Physics	2	3	2	14
Total	6	7	6	24

FALL TERM 1919.

Physics 1d	2	2	2	103
Physics 2d	2	2	2	120
Physics 4a	2	0	2	12
Prep. Physics	2	3	2	45
Total	8	7	8	280

WINTER TERM 1920

Physics 1e	2	2	2	111
Physics 2e	2	2	2	109
Physics 3e	2	1	4	78
Prep. Physics	2	3	2	30
Short Course	5	0	5	18
Total	13	8	15	346

SPRING TERM 1920

Physics 2f	2	2	2	107
Physics 3d	2	2	2	69
Physics 4b	2	0	2	22
Physics 5	2	2	2	7
Prep. Physics	2	3	2	15
Total	10	9	10	220
Total enrolled in all courses throughout the year				945

REPORT OF LIBRARIAN.

President F. S. Kedzie, Michigan Agricultural College.

Dear Sir: I have the honor to present the following report on the library for the year ending June 30th, 1920.

The total number of additions to the library was 815 books, and 132 pamphlets and unbound books.

Of the bound volumes 485 were purchased, 58 were gifts, and 272 came by binding. Unbound books and pamphlets were acknowledged when received, therefore individual mention is here omitted.

We are indebted as follows for bound volumes presented to us.

American Red Cross, 1	Massachusetts, 3
Beal, Dr. J. W., 1	Michigan, 13
Crotty, John, 1	Missouri, 1
Canada, 6	New York, 1
Columbus Horticultural Society, 1	Postum Cereal Co., 1
Funk & Wagnalls Pub. Co., 1	Smithsonian Institution, 4
Iowa, 2	Successful Farming Pub. Co., 4
Kansas, 1	Phelan, Pool, Billiards and Bowling Alleys.
McClurg Co., 1	U. S. Dept of Agriculture, 8
McDaniels, Eugenia, 2	Wrightson, Major P. G., 2

The following is a list of publications received by the library as gifts from publishers, or in exchange for our own publications.

Agricultural gazette of Canada.	Better business.
Agrl. gazette of N. S. Wales.	Better fruit.
Agrl. journal of India.	Blue Valley bulletin.
Agrl. review.	Boletim de agriculura Sao Paulo.
American seedsman.	Boletin agricola Republica de Panama.
Annals of Missouri botanical garden.	Brooklyn botanic garden, record and leaflets.
America.	Bulletin of the Grand Rapids public library.
American economist.	Bulletin of N. Y. botanical gardens.
American farming.	Bulletin of the Pan American union.
American fruit grower. (Green's).	Bulletin of the Boston museum of fine arts.
American food journal.	California citograph.
American Hebrew.	Chester white journal.
American issue.	California academy of science, proc.
American miller.	California home and farmer.
American poultry advocate.	Canadian horticulturist.
American sheepbreeder.	Commerce reports, U. S.
American swineherd.	Congressional record.
Anustralasian.	
Australian museum, records.	
Blue triangle news.	
Belding banner.	
Berkshire world and Cornhill stockman.	

Detroit education bulletin.	Flour and feed.
Dairy record.	Green book.
Dakota farmer.	Guarantee Trust Co., N. Y.
Doherty news.	letters.
Duroc bulletin.	Guarantee news.
East Lansing community life.	Guernsey breeders' journal.
Eaton Rapids journal.	Highway magazine.
Electric traction.	Hawaiian forester.
Electrical trade.	Hoard's dairyman.
Elgin dairy report.	Holcad.
Etude.	Holstein-Friesian world.
Farmington enterprise.	Il Giornale d'Italia Agricolo.
Florida huggist.	Illustrated review.
Flower grower.	Improvement era.
France, Etat Unis.	Indiana farmers' guide.
Farm and fireside.	Investment bankers' assn. of Ameri-
Farm and home.	ca, bulletin.
Farm journal.	Illumination engineer.
Farm machinery; farm power.	India, Agricultural publications.
Farmer's advocate.	Indian's friend.
Feeding stuffs.	Indicator.
Field.	Ingham Co. news.
Field and farm.	

International Institute of Agriculture, publications as follows:

Bulletin of agricultural intelli-	Manistique courier record.
gence and plant diseases.	Market reporter.
Bulletin of economic and social	Mexican review.
intelligence.	Mich. business farming.
Bulletin of agrl. and commercial	Mich. history magazine.
statistics.	Michigan library bulletin.
James barn magazine.	Mich. out-of-doors.
Jonesville independent.	Michigan patron.
Japan society, bulletin.	Midland naturalist.
Jewish farmer.	Moderator-topics.
Johns Hopkins Univ. circulars.	Monthly bulletin, state comm'r
Journal of agrl. research.	of hort., Cal.
Journal of agriculture, Victoria.	Monthly crop reporter.
Jl. of the American bankers' asso-	Monthly review, U. S. Labor
ciation.	bureau.
Jl. of the board of agr. and fish-	Midland sun.
eries, London.	National provisioner.
Jl. of the college of agri., Tokio.	News bulletin.
Jl. of the college of agri., Sapporo.	National farmer.
Jl. of the dept. of agri., S. Aus-	National grange monthly.
tralia.	National stockman and farmer.
Lilly scientific bulletin.	National weather and crop bulletin.
Lister institute of preventive med-	N. Y. Meteorology, Draper's hour-
icine, trans.	ly readings.
Live stock report (Clay Robin-	Official gazette, U. S. Patent Of-
son).	fice.

Ohio farmer.	Rockefeller Institute for medical research, studies.
Orange Judd farmer.	Shorthorn in America.
Our dumb animals.	School life.
Pan American union, bulletin.	Seed world.
Panama Canal record.	Smithsonian institution.
Philippine agrl. review.	contrib. to U. S. National herbarium.
Philippine agriculturist.	Bul. of U. S. national museum.
Philippine bureau of science, reports.	miscel. collections.
Prairie farmer.	Social service review.
Progressive farmer.	University of California, publications.
Pacific dairy review.	Agrl. science.
Park and cemetery.	Zoology.
Poland China journal.	Useful poultry culture.
Power farming.	Vocational summary, U. S.
Practical farming.	Washtenaw post.
Proc. Amer. Philos. Soc., Phila.	West Coast leader, Lima, Peru.
Public health reports, U. S. Marine hospital.	Wallace farmer.
Rice institute pamphlet.	Washington farmer.
Rotarian.	Weather review.
Reclamation record.	Weekly news letter.
Reliable poultry record.	West Indian bulletin.
Revista Indus. Agricola de Tucuman.	Western honey bee.
Rhodesia agrl. journal.	Wilson bulletin.
	Wilson bulletin, (Oberlin).

We would respectfully suggest that certain of the German publications, which were not to be obtained during the war, and which were not renewed after the war, be restored to the periodical list for the coming year, and back numbers secured if possible. They form a valuable part of our collection, and will be more and more difficult to obtain as time goes on.

The publications of the U. S. Dept. of Agriculture, and the bulletins of the various state experiment stations, together with the indexes, are received and filed in the library.

We also receive and keep on file the catalogues of the leading educational institutions of the country. These are received in exchange for our own catalogue.

We take occasion to express our appreciation of the kindness of the librarians of the U. S. Dept. of Agriculture, and the University of Michigan in extending to us the courtesy of loans of books and periodicals from their respective libraries.

Library hours have remained unchanged during the year. One of the assistants, Mrs. Sessions, resigned on April 1st, and we have appreciated the work of Miss Palma, who willingly accepted additional duties imposed upon her by reason of this loss of help.

Our student assistant, Mr. W. S. Fowle, was graduated this year. By his uniform courtesy and efficient service, Mr. Fowle made many friends among the patrons of the library, and we are sorry to lose him.

For the coming year we have been fortunate in securing the services of Miss Cora L. Feldkamp, who comes to us with the title of Reference Librarian. Miss Feldkamp is a graduate of M. A. C., and was for three years after graduation, an assistant in the library, leaving us for the position of librarian in the U. S. Dept. of Agriculture, Bureau of Farm Management. Her many friends at the college are glad to welcome her return to us.

To the library of the Experiment Station 72 books have been added, of which 9 were purchased, 8 were gifts, and 55 came by binding. This library numbers 4785 volumes. The College library numbers 40658 volumes. Total in both libraries, 45443 volumes.

Respectfully submitted,
LINDA E. LANDON, Librarian.

East Lansing, Mich., June 30, 1920.

REPORT OF REGISTRAR.

President F. S. Kedzie,
Michigan Agricultural College.

Dear Sir:

I have the honor to present the following report of the Registrar's Office for the year ending June 30, 1920:

In the regular college courses the enrollment for the year is as follows:

Agriculture and Forestry	562	
Engineering	466	
Home Economics	350	
Veterinary	34	
	<hr/>	
Total		1,412
Summer School	497	
Graduate Course	13	
	<hr/>	
Total		420
Short Courses,		
Two-year course in Agriculture	288	
Eight weeks' course in Agriculture	36	
Four weeks' course in Poultry Husbandry.....	15	
Four weeks' Farm Truck & Tractor Course	169	
Two weeks' course in Gardening	9	
Two weeks' course in Beekeeping	13	
Two weeks' course in Cow Testing and Dairy Barn Management	30	
Two weeks' course in Ice Cream Making.....	13	
One week Experienced Creamerymen's Course....	13	
	<hr/>	
Total		577
College Preparatory (Soldiers & Sailors).....		64
Total in all Courses		2,473
Names repeated		306
	<hr/>	
Net total		2,167

ENROLLMENT BY TERMS.

Course	Fall.	Winter.	Spring.	Summer.
Agriculture and Forestry.....	514	508	450	148
Engineering.....	448	411	391	124
Home Economics.....	347	336	321	92
Veterinary Medicine.....	32	30	28	4
Graduate.....	11	13	8	1
Preparatory Soldiers and Sailors.....	49	40	27	24
Federal Vocational.....			53	1
Rural Teachers.....				11
Totals.....	1,401	1,341	1,278	404

ENROLLMENT BY CLASSES.

	Agr.	For.	Eng.	H. E.	Vet. Med.	Totals.
Graduates.....	10		1	1	1	13
Seniors.....	107	8	51	70	9	245
Juniors.....	82	8	76	50	8	224
Sophomores.....	109	21	116	72	8	326
Freshmen.....	201		223	116	9	579
Special Students.....	23			12		35
Summer Session.....	136	9	124	92	4	368
Rural Teachers.....						11
Totals.....	671	49	591	443	39	1,804

GEOGRAPHICAL DISTRIBUTION OF STUDENTS.

MICHIGAN.

Counties.	Counties.	Counties.
Alger.....1	Hillsdale.....18	Missaukee.....7
Allegan.....20	Houghton.....13	Monroe.....12
Alpena.....11	Huron.....16	Montcalm.....12
Antrim.....13	Ingham.....254	Montmorency.....1
Baraga.....2	Ionia.....19	Muskegon.....10
Barry.....10	Iosco.....2	Newaygo.....14
Bay.....15	Iron.....6	Oakland.....28
Benzie.....9	Isabella.....3	Oceana.....18
Berrien.....26	Jackson.....40	Ogemaw.....3
Branch.....15	Kalamazoo.....19	Ontonagon.....3
Calhoun.....26	Kalkaska.....2	Osceola.....5
Cass.....17	Kent.....51	Ottawa.....22
Charlevoix.....8	Lapeer.....20	Presque Isle.....2
Cheboygan.....3	Leelanau.....1	Roscommon.....3
Chippewa.....4	Lenawee.....17	Saginaw.....35
Clare.....1	Livingston.....16	Sanilac.....20
Clinton.....16	Luce.....3	Schoolcraft.....1
Delta.....16	Macomb.....8	Shiawassee.....32
Dickinson.....9	Mackinac.....4	St. Clair.....22
Eaton.....25	Manistee.....5	St. Joseph.....21
Emmet.....4	Marquette.....8	Tuscola.....8
Genesee.....39	Mason.....19	Van Buren.....23
Gladwin.....3	Meosota.....8	Washtenaw.....16
Gazette.....1	Menominee.....4	Wayne.....77
Grand Traverse.....22	Midland.....3	Wexford.....3
Grafton.....17		

OTHER STATES AND COUNTRIES.

Alabama.....	2	Egypt.....	1	North Dakota.....	1
Asia Minor.....	1	Florida.....	3	Ohio.....	27
Armenia.....	1	Illinois.....	23	Oklahoma.....	1
California.....	1	Indiana.....	5	Pennsylvania.....	8
Canada.....	1	Massachusetts.....	4	Phillipine Islands.....	2
China.....	2	Minnesota.....	3	South Dakota.....	1
Colorado.....	1	Montana.....	1	Turkey.....	1
Connecticut.....	3	New Jersey.....	5	Vermont.....	4
Delaware.....	3	New York.....	34	West Virginia.....	4

STUDENTS ENTERING DURING THE YEAR 1919-1920.

Number Enrolled.

Agricultural and Forestry Course.....	195
Engineering Course.....	227
Home Economics Course.....	155
Veterinary Medicine.....	8
Total.....	585

Preparation.

Graduates of Accredited High Schools.....	551
High School Credits and Examinations.....	2
Credits from Other Colleges.....	32
Total.....	585

DEGREES GRANTED JUNE 16, 1920.

BACHELOR OF SCIENCE.

a, Agriculture; e, Engineering; h, Home Economics; f, Forestry.

Alder, Chester Glenn, e.	Dell, Glenn William, a.
Alderman, Ovid Adile, f.	DeVries, Clarence Oliver, a.
Anderson, Irvin Victor, f.	DeYoung, Warren Edward, e.
Andrews, Chester Ward, a.	Doscher, Herman Conrad, a.
Andrews, Herbert Jerome, a.	Earsman, Willis Craig, a.
Archer, Laurence Cecil, a.	East, Rhea Anne, h.
Babcock, Gertrude Rowena, h.	Estes, Aura Moss, a.
Barnett, Gladys Ella, h.	Fillingham, Ferné Lucille, h.
Barrell, Clark Luther, a.	Flory, Olive Virginia, h.
Baske, Cora Martha, h.	Folks, Una Florine, h.
Bateman, Leon Leighton, e.	Ford, Bert J., a.
Bauer, Arthur Henry, a.	Poster, Thomas Ferris, a.
Beach, Iva May, h.	Fowle, Watson Edward, a.
Beers, Charles William, a.	Frays, Ethel Marie, h.
Bellinger, Burdette Willison, e.	Frazier, Walter Estel, e.
Benedict, George Richards, a.	Frost, Miriam, h.
Benjamin, Lester Vance, a.	Gardner, Margaret Elizabeth, h.
Bentley, Benjamin Henry, f.	Garratt, George Alfred, f.
Bishop, Ona Bernice, h.	Gebhart, Cecile Nancy, h.
Bock, Ashley Pelham, e.	Gibbs, Jay Franklin, e.
Boman, William Clinton, a.	Gillette, Emma Genevieve, a.
Bottimer, Lawrence John, a.	Gorsline, Robert Howard, a.
Bristol, Willito Kelsey, a.	Graham, Edith Margaret, h.
Brooks, Berle J., a.	Green, Lola Belle, h.
Bryant, Rutherford Urial, a.	Green, Oliver Meakins, a.
Bunting, Harold Lewis, e.	Hach, Edward Carl, e.
Burdick, John Milton, a.	Haight, Howard Phelps, a.
Burrell, Norma Katherine, h.	Hart, Melvin Cassander, e.
Butler, Mary Marie, h.	Healsey, Roy Merchant, e.
Campbell, Bernice Miriam, h.	Hendershott, Karl Jed, a.
Carpp, Edward Eaton, a.	Hetrick, Russell Earl, f.
Cavanagh, Dwight C., a.	Hidrosollo, Ludovico, a.
Ceas, Nellie Edna, h.	Hill, Stanley Rowland, e.
Chynoweth, John Benjamin, e.	Hiller, Clarence Howard, a.
Clark, Edwin Russell, a.	Hill'ard, Helen Marie, h.
Clark, Rodger Sherman, e.	Himmelein, Margaret Wilamina, h.
Cockerton, Ellen May, h.	Hoffman, Howard Verne, e.
Cole, Bertine Lynette, h.	Holt, John Sanford, e.
Coleman, Claude, e.	Hopperstead, Arnold Melvin, e.
Collingwood, Laura, h.	House, L. C., a.
Coryell, Sherman, Jr., a.	Hedan, Santiago, a.
Crocker, Martin Richardson, e.	Jameson, H. Burton, a.
Cudaback, Walter Harold, a.	Jewett, Arthur William, Jr., a.
Currie, Carleton Hammond, e.	Jewett, Maurice Gordon, e.
Dane, Ruth, h.	Johnson, Harold MacLean, a.
Davies, Rex Maurice, e.	Johnston, Stanley, a.

- Jones, Leland Niel, e.
 Karkau, Edward Louis, e.
 Keck, Bertha Helena, h.
 Kempf, Dorothea, h.
 Kernen, Kenneth Crossett, e.
 Keydel, Hans Bernard, a.
 Kidd, Edna Marian, h.
 Kingery, Richard Henry, a.
 Kling, Ralph B., e.
 Klotz, Leo Joseph, a.
 Knight, Basil Thomas, a.
 Koleman, Norman David, f.
 Kunze, Elmer Frederick, a.
 Krebs, Harold Malcolm, e.
 Kurtz, Laurence Dillar, a.
 Kyes, Lennah Elvira, h.
 Laidlaw, Marian Esther, h.
 Lankton, Glenn Earl, e.
 Larrabee, Mary Louise, h.
 Leddick, Roth Merrill, e.
 Leenhouts, Edward John, a.
 Lillie, Barbara Julia, h.
 Loomis, Ferne Feneita, h.
 Lundin, Per Gunard, a.
 Lyman, Bertha Downing, h.
 McBain, Ralph Sherman, a.
 McFadden, Herbert Floyd, a.
 McKinley, Agnes Mildred, h.
 McLean, Cecil John, e.
 Malasky, Edward Andrew, a.
 Martin, Roscoe Julian, a.
 Mattoon, Mildred Agnes, h.
 Meanwell, Cyril Foster, e.
 Middlemiss, Eli William, a.
 Miles, Ruth Evelyn, h.
 Miller, Carl Frederick, e.
 Miller, Wilbert Eli, a.
 Mills, George H., a.
 Mills, Harold Newcombe, e.
 Mills, Wilfred Douglas, a.
 Montgomery, Russell Francis, a.
 Mosher, Roscoe Adelbert, a.
 Myers, Harvey Lincoln, a.
 Nesman, Albert Neil, a.
 Neville, Anne Leola, h.
 Newton, Ruth Ellen, h.
 Noddins, Raymond Woodbridge, e.
 Normington, Marian Lucile, h.
 Oechsle, Kunigunde Bertha, h.
 Overholt, Elmer Jewell, a.
 Parsons, Mahlon Phillips, a.
 Perkins, Eaton Fuller, e.
 Perry, Clara Louzema, h.
 Peters, Howard Floyd, a.
 Pettigrove, Herbert Russell, a.
 Pitt, Norman James, e.
 Post, Robert Edwin, a.
 Powell, Stanley Maurice, a.
 Ramey, Duane F., a.
 Ramsay, Clarence Frederick, a.
 Reeves, Merritt Augustus Rose, e.
 Renwick, Howard M., a.
 Rice, Rosselyn Adelia, h.
 Richardson, Don Merritt, a.
 Rigtterink, Harold Wilson, a.
 Rood, Clare Alfred, a.
 Rossman, Phyllis Elizabeth, h.
 Rothrock, Stanley Swigart, a.
 Saxton, Harry Robertson, f.
 Schneider, Corwin Janson, a.
 Schnur, Harvey Henry, a.
 Schreiber, Anna Marie, h.
 Scott, Dorothy, h.
 Severance, Esther Lois, h.
 Shenefield, Roland A., e.
 Shumway, Guy Charles, e.
 Silcox, Charles Newell, a.
 Skoog, Esther Johanna, h.
 Smith, Edith Isabella, h.
 Smith, Kathleen Evangeline, h.
 Snider, Irving John, a.
 Snyder, Ethel Marie, h.
 Snyder, Plummer Abraham, a.
 Spencer, Lloyd A., a.
 Stafford, Henrietta Maude, h.
 Steinbauer, Walter Henry, a.
 Steinholm, Frank August, a.
 Stewart, Raymond Harry, e.
 Scitt, Gladys Fay, h.
 Tappan, Agnes Jean, h.
 Tate, Esther Isabella, h.
 Taylor, William Vernon, e.
 Tiedemann, George William, e.
 Townsend, Milton Coan, a.
 Trippensee, Reuben Edwin, a.
 Unruh, Elmer Roy, e.
 Vaughn, Harold McGlothlin, a.
 Veneklasen, Harold Benjamin, a.
 Vernon, Alice May, h.
 VonSpracken, Peter Richard, e.
 Wagner, Joseph Wayland, a.
 Ward, Verne Elisha, a.
 Warren, Carl Lafayette, a.
 Webb, Walter Egbert, f.
 Wernette, D'Arcy Lionel, e.
 Wible, George Dwight, e.
 Wightman, Irene, h.
 Wiggins, Clifford Rumley, e.
 Wilder, Harriet Elizabeth, h.
 Wildern, Frank Harold, a.
 Williams, Marjorie Frances, h.
 Williams, Mary Jeanette, h.
 Wilson, Garrett Smith, a.
 Winston, Arthur William, e.
 Wolford, Melvin Blair, a.
 Wright, Ruel Norval, a.
 Wyckoff, Ralph Dewey, e.
 Yaeger, John Frederick, a.
 Young, Ada Mabel, h.
 Ynll, Paul Cornelius, a.
 Zachariah, Josephine Alice, h.
 Zimmerman, Lewis William, a.

DOCTOR OF VETERINARY MEDICINE.

- Dikmans, Gerard.
 Erbach, William Adolph.
 George, Albert Edward.
 Gregg, Alfred James.
 Hall, Warren Payne Stow.
 Palmer, Lynn Courtland.
 Pless, Louis Russell.
 Redfearn, Ernest Everett.

MASTER OF SCIENCE.

- Bennett, Caryle Wilson.
 Kotila, John Ernest.
 Tweed, Robert L.
 Wyant, Royce Willard.

MASTER OF AGRICULTURE.

John Eric Burnett.

MASTER OF HORTICULTURE.

- Hart, Ernest.
 Olney, Albert Jackson.

ELECTRICAL ENGINEER.

Smith, Harold Leonard,

STATE BOARD OF AGRICULTURE.

HONORARY DEGREES.

French, Hiram Taylor, D. Sc.

Woodworth, Philip Bell, D. Sc.

DEGREES GRANTED DECEMBER 19, 1919.

BACHELOR OF SCIENCE.

Adams, Eldon Douglas, a.	Huxtable, Robert Burgess, a.
Alkin, Arthur William, c.	Joel, Arthur Henry, a.
Behler, Harold H., a.	Joel, Henry George, a.
Benkert, Edwin Robert, c.	Kinn, Howard Everett, a.
Bennett, Jesse Merle, I.	Latter, Byron Floyd, a.
Bentley, George Truax, c.	Lyon, Don Scott, a.
Borgman, Paul Gregory, a.	McGaw, Ralph Loughley, c.
Burns, Katherine Wells, h.	Maxfield, George Granville, a.
Callard, Charles Gordon, c.	Miller, Lawrence William, a.
Crandall, Elbert Douglas, c.	Osborne, Edgar, c.
Deal, Kirk James, a.	Tenny, Ralph Whitcomb, a.
Diamond, Joseph Mordecai, a.	Thayer, Harold Forester, a.
Downer, Alvin Emery, c.	Thies, Wilbur Herman, a.
Franson, Harry Elliot, a.	Thomas, Wesley Edgar, c.
Gibbs, Ray Thomas, a.	Eugen, Emur Eugene, a.
Hain, Russell Messenger, a.	VanLeeuwen, Earl R., a.
Hawood, Winnie Eloise, h.	Virdup, Hyman, a.
Halbach, Fred Gustave, a.	Walker, Richard, a.
Halband, Clarence Milton, a.	Wass, Henry Collins, c.
Heath, Frank Robert, a.	Way, Elmer Francis, c.
Himebaugh, Harold Hollister, c.	Wellman, Stanley Frederick, a.
Howell, Paul Augustus, c.	White, Cecil Clinton, c.

SUMMARY OF DEGREES GRANTED DURING THE YEAR OF 1919-1920.

Bachelor of Science:	
Agricultural Course	123
Engineering Course	62
Home Economics Course	61
Forestry Course	9
Total	255
Doctor of Veterinary Medicine	8
Master of Science	1
Professional Degrees	1
Honorary Degrees	2
Total	276

I wish at this time to express my appreciation of the loyal and efficient service rendered by my co workers, Miss Anna Perle and Miss Delia Bemis.

Respectfully,

ELIDA YAKELLEY,

Registrar.

East Lansing, Mich., June 30, 1920.

SUMMER REPORT.

President F. S. Kedzie,
College.

Dear President Kedzie: Another Summer Session has come and gone. I shall embody in this report a few important statistics which may assist the reader of the report to a better understanding of what is done here in these Summer Sessions.

Total enrollment	320
Number of men enrolled	254
Number of women enrolled	66
Number of regular students	239
Number of teachers	54
Number of new students	27
Distribution among the various courses was as follows:	
Animal Husbandry	43
Bacteriology	41
Botany	18
Chemistry	78
Dairy Husbandry	47
Drawing and Design	24
Economics	20
Education	19
English and Modern Languages	81
Entomology	9
Farm Crops	32
Farm Mechanics	31
Forestry	26
History and Political Science	29
Household Science	24
Household Art	24
Horticulture	34
Mathematics	85
Mechanical Engineering	44
Music	6
Physies	12
Poultry	43
Rural Teachers.	
Rural Entertainment	7
Rural Education	11
Nature Study	4

The following comments are suggested by the above data and the experience of administration.

(1). The fact that our attendance this year has been the largest normal attendance thus far, is indication that the session is serving a worthwhile purpose. Summer attendance is necessarily a matter of slow growth. Time is required to acquaint individuals with the op

portunities offered here during the summer, as well as for us to find out what should be offered during the session.

(2). A very excellent group of teachers has been with us this year. Among these was a sub-group of ten mature men—superintendents and principals in public schools—who are preparing themselves to teach agriculture under the provisions of the Smith-Hughes law. This group has the promise of a much larger number next year, on account of the rapid progress in the consolidation of rural schools in our State. For the most part these men are already well trained and are adjusting themselves to this new field. They are likely to spend several summers here, and some will continue for our degree. In view of this fact, I suggest that the College arrange a group of studies to be pursued by these men. These courses would consist of the technical work which the men need for their purposes. An orderly arrangement would be advantageous both to the College and to the men, over the chance classification.

(3). Some method must be devised to bring a larger number of teachers to our summer courses. Several reasons prompt this suggestion. Foremost is the fact that I believe that M. A. C. offers a very good type of training in educational lines for teachers. According to official reports, more than one half of our boys and girls in the public schools are attendants upon rural and village schools, where they are trained by the city reared and trained teacher. There is something incongruous in our expectation that boys and girls are going to acquire a deep abiding regard for things rural if, in the most impressionable years of their lives, they are taught by men and women who have no intimate or first hand knowledge of country life. The very least we can do is to have a hand in establishing the intellectual attitude for our teachers. It seems to me these considerations strike at the very root of our social problem of today.

Again, we have one of the most splendidly prepared teaching forces to be found anywhere, whose time in a large number of cases, is not utilized by the College during the summer months, and also, a physical plant of untold value for furnishing the very training our teachers need. M. A. C. arouses the sincerest appreciation in the minds of those who do come here. Why shouldn't these privileges be more widely distributed?

Finally, the State of Michigan has established a great plant here for use. As a business proposition, if the College is to be open at all, why shouldn't the State insist upon its use more nearly to capacity at this season of the year when other institutions find their capacities taxed. It seems to me this matter might meet with approval from our educational authorities with mutual profit. Lest I be misunderstood in the above comments, I wish to make it clear that I do not mean to transform M. A. C. into a competitive training school for teachers. I do urge, however, the utilization of M. A. C. by students of other schools to get the M. A. C. contribution to thinking, and her spirit.

As in previous years, many special projects have been carried on along with the Summer Session, with very great benefit to groups who cannot become students of this institution. While these efforts entail some additional expense, I think they bring their own reward to the institution

since they are effective means of acquainting the general public with the work of this College.

Enumerating these features in order, we mention first, the conference in Home Economics and Citizenship under the direction of Dean Mary E. Edmonds and Prof. Mary Hendrick. A goodly number of teachers and other individuals came to this most excellent program, consisting of lectures by members of our own faculty, supplemented by visiting lecturers, including Miss Laura Baldtz and Mrs. Mary Swartz Rose of Columbia University and Miss Zella Bigelow of Washington, D. C.

Following this came the Boys and Girls Club Conference. This gathering was largely attended and a most successful program was presented.

During the last week, about fifty teachers of Agriculture in high schools of the State, returned for a week of instruction in courses especially prepared for them by members of our teaching force. This year the courses included Drawing, Manual Training, Gasoline Engines, Plant Diseases, Insect Pests. The work had been arranged by Supt. E. E. Gallup and Prof. W. H. French.

Another conspicuous gathering has been the presence of more than 150 ministers on the campus in attendance on the Rural Conference July 6 to 16. This was the sixth annual gathering and probably the best that has ever been held, both from the standpoint of strength of program presented and interest manifested by those in attendance. The program dealt with topics of great importance pertaining to rural affairs and they were presented by men of exceptional preparedness for this work. The College is indebted to Dr. Warren H. Wilson whose efficient direction made this gathering the most successful thus far.

This Conference program is greatly indebted to members of our own College faculty. Dr. Eben Mumford has continued his invaluable services this year through his lectures upon "Agriculture and Rural Life." His familiarity with the rural problems of the State, places him in a position which few men occupy, for interpreting rural life. He has performed the most incalculable service from year to year in presenting to these groups in his scholarly way, the problems of rural life.

Prof. W. W. Johnston has repeated this year, his lectures upon "Recent Tendencies in Literature." This course of lectures like a similar course of last year, was pronounced by the hearers as one of the best furnished by the College.

A new feature of this year, has been the introduction of lectures upon economic problems of the time or an attempt to interpret the industrial conditions of the day. This has been handled with splendid success by Prof. C. S. Dunford of the College. In view of the fact that economic conditions of today are important and at the same time very confusing to the minds of people generally, this has been a very fruitful part of the program.

These special group activities promote greater efficiency throughout the State in the performance of the various functions carried on by the respective groups. These efforts of the College could not have been done with equal satisfaction and effectiveness without the background of our Summer Session, and they in turn lend a seriousness to the college work. The two go together, and I think it would be the part of wisdom to enlarge upon this type of effort as opportunity to do so presents itself.

Much could be written in detail in this report, but I doubt the advisability of so doing. As a consequence, I have confined myself to a few important suggestions which, to my mind, mark out the course of procedure for us in the future efforts to build up the work of the Summer Session. I have faith that the cooperation of our faculty can make the Session a much larger enterprise if we can direct our efforts with continued and increased vigor in these lines.

In closing I want to testify to the splendid spirit with which the teaching staff has handled the work of the Session. I say again that I believe the best classroom and laboratory work of the year is done at this period.

E. H. RYDER,
Director of Summer Session.

East Lansing, Mich., June 30, 1920.

REPORT OF THE MILITARY DEPARTMENT.

The President,
Michigan Agricultural College.

Dear Sir:—The Military department, in handing in its annual report, wishes to invite attention to the post war conditions which have rendered its work of considerable difficulty this past year. I refer to the necessarily liberal policy toward students who have served the government during the late emergency. Hitherto, little if any, attention has been granted to pleas for exemption from our course in military training unless the claimant has been able to convince the Commandant that his work elsewhere has equalled that of our department—therein following strictly the actions of other academic departments. But with a large number of young men desiring to enter college and who had training in our war camps and abroad, I felt that, even though their training did not follow our lines, yet we should grant at least equal time credits. Doing this resulted in a greatly diminished attendance in the Military department. The War Department's annual physical examination in February also cost us some 16% of young men who could not come up to the high standard set for officer material. We trust that the War Department will show a more liberal interpretation of the requirements this next year.

For the first time in the history of the College, units other than infantry have been organized. A coast artillery unit under Capt. J. J. Teter started about Nov. 1st. The material furnished by the War Department is quite extensive, consisting of a 155 mm gun, an 8 inch howitzer, an artillery repair truck, a 5 ton tractor and a 3 ton Liberty truck. All needful paraphernalia for range finding, radio, telephonic communication, etc. is here and installed. It is a very popular course, especially with the engineer students as it fits in well with their professional work and studies. Enrollment was limited this year as we desired to try out selected young men with a view to their acting as officers in the unit next year.

A cavalry unit was also started at the opening of school. Capt. V. R. Bell was in command. Thirty horses, two mules and an escort wagon together with necessary saddle equipment, repair tools, sabers etc. are on hand. Capt. Bell was relieved from duty as he was not in the best of health and unable to carry on the rather heavy duties of his position, and Major Elliott was sent here about April 1st. Enlisted men care for the horses and for the stable and barracks allotted to our use at the Constabulary grounds. We hope that the presence of a cavalry unit will act as a stimulus for agricultural students to enter the veterinary course and perhaps to become interested in horse breeding.

With the exception of Capt. Bell, the services of all officers and men detailed here have been most satisfactory. The students have taken a much larger interest in the work of the department than ever before. The department expanded in two ways: Last winter it offered a course in rifle fire to the girls (under direct charge of Miss Grimes) and organized a club of lady faculty and one of male faculty in gallery practice. Several other clubs were organized and more than 200 enrolled, including girls, faculty and men students.

The annual inspection was held June 1st and 2nd. In the opinion of the department staff and all present competent to judge, the students acquitted themselves in splendid style. To my knowledge, every question was answered promptly and correctly and quite a good deal of praise for our high morale was given by the senior inspector at one of the dinners given for him. Steps should be taken by the college authorities to secure a three day inspection as the two days granted was entire insufficient for the purpose.

Steps should also be taken to insure that the P. M. S. T. be retained here during the summers. Supplies must be requisitioned, property taken in and inspected, sorted out and made ready for fall. Correspondence must be cared for, reports rendered, both to the War Department, and to the President, conferences with the President and deans must be held and if the P. M. S. T. is taken away while the school is in session in the summer and if the college authorities take their own vacations after the summer session closes, the P. M. S. T. may be out of direct touch with the authorities for a matter of two to three months.

I also wish to recommend most strongly that steps be taken to secure an adequate building for the Military department. With the installation of these two new units, larger facilities are urgently needed. With the growth of the college enrollment, approaching pre-war strength, the armory cannot accommodate the numbers. Small classes wherein real military instruction can be given, are impossible. Groups of more than 60 students at a time do not receive proper teaching. The day of having all classes at one hour is of the past and the R. O. T. C. plans, "make every cadet a possible future officer in time of war," cannot be carried out unless adequate facilities are provided. During the past winter there was but one vacant hour on the drill floor from Monday morning at 8 until Saturday at noon, counting the day from eight until six. And the evenings were taken two or three each week for rifle club work and every Friday and Saturday nights for social purposes.

Respectfully submitted,

P. G. WRIGHTSON,

East Lansing, Mich., June 30, 1920.

Major U. S. A.

REPORT OF THE MUSIC DEPARTMENT

President F. S. Kedzie, College.

Dear Sir: I hereby submit a report of the Department of Music for the year ending June, 1920.

What this department has accomplished in its first year, considering that we were handicapped in many ways, has been, in my judgment, very satisfactory.

There were during the year, fifty-six students enrolled in the piano department, and 167 in the voice department.

Eight of the piano students played accompaniments regularly for the voice students, thereby broadening their own horizon, and at the same time giving the vocal students necessary help. The expense of this work was taken care of by charging a small fee.

The Men's Glee Club was organized at the beginning of the winter term, and, as you know, concluded a very successful year both musically and financially. The best I believe in the history of M. A. C.

We had in connection with this the Varsity Male Quartette, which did excellent work in advertising the College. They sang in all the high schools in all the cities visited on the Glee Club trip, besides many other places.

The Girl's Glee Club was organized in the spring term, and added to the success of several occasions, as evidenced by their appearance at the commencement exercises.

Soloists have been furnished for many occasions here and elsewhere. The Mandolin Club gave splendid support at different times, especially during the Glee Club trip.

The work of the Band the past year was very creditable, and several things were accomplished which will be of permanent benefit.

We are splendidly equipped with uniforms and instruments, and we look ahead for a better band next year. The membership varied from fifty-three in the fall term to forty-five during the spring term.

The Band gave excellent support to all athletic events, Farmers' Week, concerts, Baccalaureate, Commencement, and the Pageant would have been impossible without it.

Many other things could be mentioned with which we have made progress such as: more massed singing, better singing, more young people engaged in the serious study of music, and a higher standard all the way through.

Respectfully submitted,

J. S. TAYLOR,

Director of Music.

East Lansing, Mich., June 30, 1920.

REPORT OF THE DEPARTMENT OF PHYSICAL TRAINING.

President F. S. Kedzie,

Sir: I beg the privilege of giving you the following in regard to the work of the Department of Physical Training during the past year:

Physical training either in the form of remedial, group or recreative work was required for the first time of all students of the institution, both men and women. This necessitated some ten teaching groups of women, meeting three times a week and sixteen groups of men, meeting twice a week. This large number of teaching hours brought the Gymnasium into use from 9:00 in the morning until late in the evening, six days in the week. The required work consisted of general body building and remedial work, group and mass recreative and physical activities with the army physical drill and calisthenics for the men. In addition to the physical work, lectures and talks to freshmen on health education, personal and public hygiene and kindred subjects were given throughout the year. Activities for the girls was greatly enlarged by the addition of games, swimming and group work, so that the work was better liked, more educational and productive of better results. The usual athletic teams were maintained for the men and were fairly representative of the institution. The football team played creditably against many of the strongest Western teams. The baseball team played a full schedule and made a trip into New York, Pennsylvania and Ohio, giving a certain amount of publicity to the institution in those states. The basketball team met the strongest Western teams and made a trip as far as the University of Nebraska. Athletics and recreative games were promoted and stimulated more than usual within the institution and a very large proportion of both men and women were brought into some recreative activity.

The teaching personnel was changed during the year by the resignation of George E. Gauthier, April 1, and the appointment of Arthur N. Smith of the University of Maine to take his place. I wish at this time to put on record the recognition of the splendid work of Mr. Gauthier who has been with the department since 1915. He resigned to accept a very fine position as Physical Director for the city of Bay City.

The Gymnasium and the department as a whole is now splendidly equipped. The only great need is the addition of an adequate outdoor athletic plant. Our present old wooden stands are nearly worn out and entirely inadequate. The field is too small and the annual spring floods make its use uncertain and unsatisfactory. There will be several additions in the teaching personnel of the department for next year and I feel this will give strong teaching strength and a well-rounded out staff for carrying on the physical and athletic education and supervision of all the students. I respectfully call your attention to the fact that the department touches the life of every student in the institution and this contact is a very vital one and plays an important part in the

building of the well-rounded out man and woman. The teaching force during the year has been as follows:

George M. Gauthier.

Lyman L. Frimodig.

Arthur N. Smith

John Heppinstall.

Miss Edith Casho.

Miss Helen Grimes.

Respectfully submitted,

C. L. BREWER,

Director.

East Lansing, Mich., June 30, 1920.

REPORT OF THE ALUMNI RECORDER.

President F. S. Kedzie, Michigan Agricultural College.
East Lansing, Mich.

Dear sir: The following is the annual report of the Alumni Recorder for the year beginning July 1, 1919, and ending June 30, 1920.

Alumni work, since the war, has received an impetus never before experienced, and with it increasing duties. This we believe, is due to several reasons:

First, the general increasing interest manifest in education all over the country has caused the alumnus and former student to think of education, and hence his alma mater, in a more serious manner than ever before.

Second, the men returning from the service appreciate the old ties more than ever before and wish to keep in touch with their college and friends. The gift to these men during the war, of the M. A. C. Record, from the College and M. A. C. Association, reawakened their interest in the College.

Third, the Memorial Building campaign, we believe, has done more than any other one thing, to renew interest of the right kind. This is the first big project put across by the alumni for their college, and every contributor wants to know how his money is being spent, and how the project is progressing.

Fourth, the agitation for national fraternities, the campus circle question, the dormitory problem and the renewed interest in athletics, have all called the attention of M. A. C. alumni to their college and its future.

Fifth, The Union Memorial Building campaign and additional help in the Alumni office have enabled us to issue a better Record with more news, and better keep in touch with our former students.

In the past year we have partially worked out or completely finished the following major projects:

I. *The Memorial Building Fund campaign.*

The big outstanding feature of the year's work has been the launching of the Memorial Building Fund campaign, and the reaching and sur-

passing of the goal set last commencement. At that time it was voted to raise \$150,000 to erect a Union Building as a memorial to our M. A. C. men who took part in the World war. The executive Committee presented the following report as of June 13:

MEMORIAL BUILDING FUND.

Amount subscribed by Alumni.....	\$103,600
Amount subscribed by students.....	38,403
Amount subscribed by faculty.....	9,100
Total	151,103

At the annual M. A. C. Association meeting, resolutions were passed to increase the fund to \$300,000 and possibly \$500,000, and continue the campaign next year.

II. *The College War History.*

Collecting of material for the College War History has gone on during the year, and we now have about half of the material ready for the press, or something over 500 reports complete. Work on this will continue during the summer, and we hope the volume will be ready for distribution in the fall, if paper and printing conditions are not too abnormal.

III. *Bringing of Records Up To Date.*

During the past year we have gradually been bringing our records up to date. Besides the "base" or history cards for all graduates, we now have such cards for over 2000 former students who did not finish. These cards give home address, class and course, college activities, and changes of occupation and address since leaving college. We hope before the present year is over, to have a base card for every student who finished one term at M. A. C. The Memorial Building campaign, which has necessitated circularizing every former student at least three times, has given us authentic addresses for over 5000 former M. A. C. people.

Besides having all students filed alphabetically and by classes we have them arranged geographically or according to location. By aid of our addressing machine and individual name plates for each person, we are able to furnish lists on very short notice. Alumni moving into new fields ask for these lists, and local M. A. C. associations ask for them when holding meetings. We have furnished them to different departments of the college, and they may be utilized in college publicity work.

IV. *Editing the M. A. C. Record, the Official Organ of the M. A. C. Association.*

The M. A. C. Record has been issued forty times during the year, with an average of seventeen inches more of reading matter over the previous year. We now have a membership list of 2700. As in the past the publication of the M. A. C. Record as well as considerable of the expense of maintaining the Alumni office is paid for by the M. A. C. Association and our efforts to make it self supporting are more nearly successful than they have ever been.

V. *Helped Organize and Visited Local M. A. C. Associations.*

Seventeen new M. A. C. Associations have been organized or revived during the year with increased interest and activities in all of them. Seven visits have been made to these associations by the secretary and assistant secretary at special meetings. Fewer visits to local associations have been made by this office this year because of the many visits by members of the faculty for special Memorial Building campaign meetings.

In general, the progress and expansion of the alumni work during the past year has been most encouraging. We have supporting us several thousand loyal M. A. C. folks who have the first interests of the College at heart. Our Alumni and former students have a deep love for M. A. C. They are loyal and believe in her, and we know that during the next few years, with proper organization, they will be a powerful factor in pushing forward the work and the field of the College and increasing her popularity and effectiveness in Michigan and in other states. This year's commencement reunions, attended by nearly 600 alumni were unfailling evidence of this new spirit of alumni service to alma mater. Never have we beheld such enthusiasm and spirited interest in the College and her problems as was manifested at the annual meeting of the M. A. C. Association at the noon luncheon Commencement Day.

Alumni thought and opinion regarding future policies and the development of the Michigan Agricultural College were expressed in the following resolutions adopted by unanimous action of the M. A. C. Association at its annual meeting June 16, 1920.

"Be it resolved, That the M. A. C. Association is strongly opposed to any movement tending toward the removal of men from the dormitories at M. A. C. and be it further resolved that the Association favors the promotion of some plan which will require that all freshmen be housed in dormitories under proper supervision and that the necessary provisions be made therefor."

"Resolved, That the M. A. C. Association endorse the action of the faculty in recommending to the State Board of Agriculture that under suitable conditions the ban on National Fraternities be lifted."

"Resolved, That due to increase in the cost of printing, paper, and office administration that the M. A. C. Association dues be raised from \$2.00 per year to \$2.50 per year."

"Resolved, That the Secretary of the M. A. C. Association establish in his office a system for bringing the superior advantages of M. A. C. to the present attention of prospective college students. This is to include the possible employment of a Field Secretary and the interesting of alumni in furthering the object."

"Resolved, That the M. A. C. Association solicit the State Board of Agriculture for an appropriation to carry out the work of the alumni office in bringing students to M. A. C. and that a Committee of three be appointed to handle the matter."

Respectfully submitted,

C. W. McKIBBIN,

Alumni Recorder.

East Lansing, Mich., June 30, 1920.

REPORT OF THE STATE INSPECTOR OF NURSERIES AND ORCHARDS.

To the State Board of Agriculture.

Gentlemen: The work of the past year has been considerably hampered by the lack of funds. Heretofore, the amount available has been practically without limit, as the expenses were paid from the general fund of the State, but the amount appropriated under the Budget System for the use of the department from July 1, 1919, to June 30, 1920, was less by more than one thousand dollars than was required the previous year, and it became necessary to curtail the work in several lines.

ACTIVITIES OF THE DEPARTMENT.

The work which has been done may be classified under five heads: 1. Nursery inspection; 2. Orchard inspection for the control of dangerous insects and diseases; 3. White pine blister rust inspection; 4. Common barberry eradication; 5. Inspection of shipments of nursery stock from foreign countries.

INSPECTION OF MICHIGAN NURSERIES.

We have felt that this portion of the work must not be neglected however much we must slight the inspection work in other lines.

Owing to the low prices for which nursery trees have sold for the last five years, as well as to the scarcity of help and other causes, there has been a marked decrease in the acreage devoted to nursery stock and especially to fruit trees. On the other hand, the acreage devoted to small fruit plants and to ornamental trees and shrubs in general has shown a marked increase.

Although the cost and scarcity of reliable labor has reduced to a considerable extent the care given to the nurseries in the way of cultivation, they have in general never been in a more satisfactory condition so far as dangerous insects and diseases are concerned. The trees were entirely free from the San Jose scale and the number upon which the woolly aphis and crown-gall were found was very small. When either crown-gall or woolly aphis were found on the trees either when growing in the nursery or after they were dug, the inspected trees were destroyed.

Several of the canning factories in Michigan in order to increase the supply of raspberries, especially the black-caps for their use, are aiding the growers in securing a supply of plants and have contracted for large numbers of plants at wholesale prices and have supplied them to their patrons at cost.

In order to make sure that the plantations thus made will be free from dangerous diseases and insects we arranged to have these plants inspected. Under this arrangement several hundred thousand raspberry and strawberry plants were inspected, mostly in Van Buren county.

The vicinity of Bridgman, Berrien county, has a country-wide reputation for the many nurseries located there which ship millions of strawberry and raspberry plants each season. Many of the licensed nurseries

are not able to grow all of the plants they sell and arrange with neighboring fruit growers to supply them with plants from stock furnished by the nurseries. More than one hundred such plantations were inspected during the past year.

INSPECTION OF MICHIGAN ORCHARDS.

The high price at which fruit has sold during the last two or three years has not only led to the planting of many new orchards, despite the high cost and the scarcity of fruit trees, but has induced many farmers to give greater attention and care to the older orchards. While this is true in nearly every county in Michigan, it is in the "Fruit Belt" along Lake Michigan that it has been particularly noticeable. This has of course resulted in larger and better fruit crops and higher prices for the fruit.

Dusting vs. Spraying. The dusting of the trees in place of spraying has been adopted by many of the larger growers and has given very good results during the last two years, both in the way of controlling fungous diseases and in holding in check the canker worm, codling moth, tent-caterpillar, plum curculio and the various leaf-rollers. It is less likely to burn the leaves and especially for large trees it can be done much quicker than with a spray rig.

On the other hand, although it appears to be fully as effectual as spraying for the control of leaf-eating insects, it does not seem to give quite as good results against some of the fungi as does a liquid spray, particularly if the season is wet and hence favorable to the development of these diseases. At best, the application of dusts do not seem to be as lasting in their effect as the liquid applications, and particularly in wet seasons one or two more dustings than sprayings should be given. The other objection is the higher cost of the treatment. Thus, for a large apple tree it may cost 20 to 25 cents for dusting while the cost of the materials for spraying a similar tree is seldom more than 5 cents, or for a year it might be one dollar for dusting a tree as compared with an expense of 25 cents for the materials for spraying. Even allowing 5 cents per tree for the labor of spraying, and disregarding the labor of dusting, the cost of the latter operation would be twice as much as for spraying.

As has been stated, there is greater danger of injury to the foliage in spraying than when dust is used, but this is more commonly due to the mechanical injury by the whipping of the tender foliage with the stream from the spray-gun under a heavy pressure than to the action of the spray materials.

The greater gain from the use of the dusting machine comes from the ability to cover the trees quickly and hence give them a protecting coat at the proper time, while with a spray rig a week may be required to spray a large orchard and in the mean time opportunity is given for the attack of insects and for infection by fungi. Owners of large orchards will certainly find it helpful to have a dusting machine.

The San Jose Scale. In 1918 very little San Jose scale was found in Michigan, but in 1919 it had become more plentiful and did considerable harm to neglected orchards. In 1920 the number of infested orchards has been even greater. In one township, 35 orchards were found infested, some of them quite badly, in one of the central counties in which little harm had been done in the past.

To call the attention of fruit growers to the danger which threatens the orchard interests, and to point out the method of bringing the San Jose scale under control, the following circular was prepared and sent to numerous newspapers and to fruit growers:

"Fight the San Jose Scale." "During the last twenty years, hundreds of fruit trees have been killed in Michigan by the San Jose scale. This has been needless since cheap and effectual remedies have been found.

"Two years ago it was hoped that the numbers of the scale had been so reduced by climatic conditions and insect parasites there would be little trouble from this insect in the future, but the past season was so favorable for its development that many trees which did not receive treatment became so badly infested during the summer that the branches were seriously injured and the fruit was condemned for marketing. To check the spread of this insect and to prevent further injury to the trees now infested, every owner of fruit trees in sections where the San Jose scale has been found in previous years should see that his trees are sprayed before the buds open.

"There are two effectual remedies, either commercial lime-sulphur solution, diluted at the rate of one to eight parts of water, or "Scalecide" at the rate of one to fifteen parts of water. The latter is a soluble oil preparation which has the merit of spreading along the branches, in this way reducing the amount required considerably less than when lime-sulphur solution is used. Hence, even though applied with a very fine nozzle it will be likely to reach all of the scales, if reasonable care is taken to cover the branches.

"On the other hand, lime-sulphur solution is an excellent fungicide, and is helpful also in controlling the diseases of fruit trees. For this purpose, it may be used at the winter strength up to the time the blossoms show color, without reducing the fruit crop, or permanently injuring the foliage, although it may burn the edges of the leaves in the opening buds. Even this injury can be largely prevented by slightly reducing the pressure and using a comparatively fine nozzle.

"Applied at this time, lime-sulphur solution will destroy the San Jose scale upon the trees and also serve as the early cluster-bud spray for apple and pear scab and other fungous diseases. The benefits from either of these will repay many times the cost of the application. The present price of fruit, warrants a fight for a clean crop, especially as the scale may get their orchards if farmers fail to do so."

The Codling Moth. For several years the codling moth has done considerable harm to orchards that were thought by the owners to have been thoroughly sprayed. Trees which were free from wormy apples during the first part of July were found to be badly infested later in the season. This was the case where the trees were given two applications in June after the fruit had set and received another application during the first week in August for the second brood of worms. The trouble was ascribed to the early development of the second brood, owing to the warm season, and the fact that the worms had entered the fruit before the August application was made. In most, if not all cases, it is probable that the worms which entered the apples during the month of July were delayed specimens of the first brood rather than early individuals of the second brood.

Careful observations covering periods of several years have been made in a number of States and it has been well established that a period of six weeks may elapse between the time of the first specimens of the first brood appear, and the hatching of the last individuals of that brood.

While many fruit growers give their trees only one application after the fruit sets, a majority of them follow this application with another two or three weeks later, and then spray for the second brood the first week in August. This practice leaves six or seven weeks between the date of the last spraying in June and the first spraying in August, and as the larvae of the codling moth will be hatching every day during that period we may expect during the latter part of July a large proportion of the worms will be able to enter the apples in spite of the poison applied six or seven weeks before. We are convinced that in sections where this insect is plentiful, the only safe method is to spray or dust the trees as often as once in two or three weeks from the time the fruit sets until the middle of August. This means that at least four treatments should be given winter varieties of apples after the fruit has set, and if the worms have been plentiful and the season is rainy so that the poison is washed off as many as six applications may be worth while.

During the spring of 1920 a circular covering the above points was quite generally distributed through the press and by mailing copies to individuals.

The Control of Apple Scab. The past two seasons have not been favorable for the development of the fungus which causes "scab" on the fruit and foliage of apples, but there was sufficient development of the disease to show that good fruit cannot be grown without spraying.

In some sections it was cold and wet at about the time the buds opened and there was conclusive evidence of the value of the pre-pink spray. If we make the first application as soon as the first sign of growth shows and repeat the application often enough to keep the leaves and fruit covered, we will be sure to have foliage and fruit free from this disease. The June drop is sometimes largely due to the attack of apple scab.

As a rule, it will be safe to make but one application before the blossoms open but if ten days have elapsed after the pre-pink spray and the petals have not opened it will be well to make a second application. We would then spray within a week after the petals have fallen, and repeat it every two or three weeks up to the first of August. An application about the middle of August would also be worth while for winter varieties that are especially subject to attack, if the weather is wet and favorable for the development of the disease.

We are glad to report that not only was spraying never more general than it has been this year in the commercial orchard section, but it has never been as thorough and the results will certainly be seen in the quantity as well as the quality of the fruit sold this autumn.

The Canker Worm. Although seldom if ever entirely absent from the State, the Canker worm has not been generally distributed for a number of years. In the spring of 1920 it did more harm than for 25 years, and its work was quite noticeable in most of the counties in the southern half of the State. It was generally in orchards that had not been sprayed and when its presence was noted it was too late for effectual spraying. These orchards had the appearance of having been burned. In a num-

ber of sprayed orchards, the worms made considerable headway, largely due to the use of too little arsenate of lead in the sprayings before and after the blooming period, thus permitting the larvae to attain considerable size, and making it difficult to kill them when spraying for their control began in earnest after the fruit had set.

When allowed to feed unchecked, this insect will not only destroy the fruit crop but will kill the trees if allowed to strip them for three or four years. To control them, the trees should be kept covered with an arsenical from the time the worms hatch in May until they have all been killed. It will not do to begin spraying when the work of the insects on the trees can be seen.

Two pounds of powdered arsenate of lead or one and one-half pounds of arsenate of calcium should be used for 50 gallons of water. The latter is the more effectual but as it is likely to injure the foliage, three pounds of lime should be added.

The first application should be made just before the blossoms open. In case the weather is cold and wet, and the opening of the blossoms is delayed for a week, another application should be made to orchards that are known to be infested.

As soon as most of the petals have fallen another application should be made, and repeated in ten days or two weeks. In case the insects get much of a headway before the trees are sprayed, the amount of the arsenical may be increased to $2\frac{1}{2}$ or even 3 pounds in 50 gallons of water.

WHITE PINE BLISTER RUST INSPECTION.

Owing to the small apportionment of funds for the work of the department very little white pine blister rust scouting has been done, except as it could be done in connection with the regular work.

Fortunately we had arranged to cooperate with the Federal Department of Agriculture in this branch of the inspection service, and the State was again quite generally covered by scouts furnished and paid by the Federal department. Since July 1, 1919, not a single tree infected with the white pine blister rust has been found in Michigan. In this we are more fortunate than Wisconsin and Minnesota where the disease has become widespread and all hope of wiping it out has been given up. The same is true of large sections of New York, New England and Ontario where it first appeared in this country.

Arrangements we trust can be made for continuing the scouting, especially along the Wisconsin and Canadian border and in sections where the trees from nurseries in which the disease was found have been planted.

ERADICATION OF THE COMMON BARBERRY.

Not only has the lack of funds prevented the department from continuing the special inspection work for the locating and bringing about the destruction of the common or tall barberry, which spreads the spores of the wheat rust, but the Federal funds available for the purpose have also been very small.

Very little work has been done except by Walter F. Reddy who was assigned by the Department of Agriculture to take charge of the work

in Michigan, and what we have been able to do in connection with the regular work of this department.

INSPECTION OF IMPORTED NURSERY STOCK.

Owing to the Federal quarantine against nursery stock from foreign countries very little stock has come in, except bulbs from Holland and Belgium. During the fall months many hundred cases were inspected and were found in good condition except a few cases of narcissus bulbs which we were obliged to destroy. They were infected by various mites, and with the narcissus fly, which is especially to be feared, since it also attacks the onion.

The other imports consisted of nearly one million apple, pear, plum, cherry, and rose stocks from France and England. These stocks were poorly packed and arrived in such a condition that many thousand could not be used. They were free from dangerous insects and diseases, but the importance of continuing this inspection service was shown by the finding of clusters of gipsy moth eggs upon similar shipments in one or two other states.

STATE QUARANTINES.

Quarantine No. 1 against shipment into Michigan of five leafed pines, currants and gooseberries from New England, New York, Wisconsin and Minnesota; and Quarantine No. 2, against shipment of the common barberry and mahonia are still in force. The latter will remain as a permanent quarantine, but we hope to be able to modify the blister rust quarantine so far as it relates to shipments of gooseberries and red and white currants from the nursery section of Central New York, provided the inspections made during the present season indicate that it can be done with safety.

Owing to the spread of the European Corn Borer in New England and its appearance in New York and Pennsylvania, it was deemed best in March, 1920, to quarantine shipments from those sections which were likely to harbor this insect. In addition to the stalks and ears of corn of all kinds and broom corn, such vegetables as have edible leaves or stems, were included in the quarantine, as well as herbaceous perennials which are shipped with their old stems attached, and hardy shrubs which have a large pith. Straw, whether to be used as such, or as packing material, is also covered by the quarantine.

To this report is appended a list of the Michigan nurseries licensed and inspected during 1919-20, and also the dealers and nurseries in other states which have a license to sell nursery stock in Michigan:

LIST OF NURSERIES LICENSED IN MICHIGAN FOR THE YEAR ENDING JUNE 30, 1920.

Alferink, Albert, Holland.
Allis, E. W., Adrian.
Anable, Geo. L., Three Rivers.
Asman, C. W., Port Huron.
Au Sable Forest Nursery, Lovells.
Baldwin, O. A. D., Bridgman.

Bangor Canning Co., Bangor.
Bashford, C. L., Mason.
Basswood Center Nursery, Stevensville.
Bliss, C. P., Harbor Springs.
Boehring Brothers, Bay City.
Bohl, William, Buchanan.
Botanical Nursery Co., Lapeer.
Breitmeyer Landscape & Nursery Co., Detroit.
Bridgman Nursery Co., Bridgman.
Brooks Co., J. C., 462 Fourth Ave., Detroit.
Brown, D. M., Grand Rapids, R. D. No. 12.
Burgess Seed and Plant Co., Galesburg.
Burmeister & Hartung, Onkama.
Campbell, Chester G., Paw Paw.
Celery City Nurseries, Kalamazoo.
Cole, Levant, Battle Creek.
Collins, Ward E., Fennville.
Coryell Nursery, The, Birmingham.
Curtis, L. T. & Son, Flint.
Cutler & Downing, Benton Harbor.
Daly, Thos. W., Watervliet.
De Gursa, Robert, Ovid.
Donahue, Charles W., Lansing.
Dunham, Enos W., Baroda.
Ellis, Daniel H., Saginaw.
Emlong & Sons, Stevensville.
Evans, M. L., Coldwater.
Ferrand, E. & Sons Company, Detroit.
Fetters, Theo. J., Harbor Springs.
Flansburgh, C. N. & Son, Jackson.
Frissel, Martin, Muskegon.
Ganzhorn, Jacob, Ann Arbor.
Glenwood Nurseries, The, Holland.
Gobleville Nurseries, Gobleville.
Greening Nursery Co., Monroe.
Grossman, C. M. Petoskey.
Gustin, Chas. F., Adrian.
Hallin, Erik, North Detroit.
Hallman, W. S., Coloma.
Hamilton, A. & Sons, Bangor.
Hampton, J. E., Bangor.
Hanes, Peter, Farmington.
Havekost, Geo. H., Monroe.
Hawley, Geo. A., Hart.
Helmer Farm Nursery, Battle Creek.
Hemingway, George R., Oak Park, Ill. (Nursery at Tronton, Mich.)
Hibbler, E. B., Detroit.
Houghtaling, Wm., Battle Creek.
Hogenfritz, E. C. Detroit.
Hogenfritz, I. E. Sons' Co., Monroe.
Insulinde Nurseries, Kalamazoo.
Jakway, James J., Benton Harbor.

Jeffrey & Son, James, Kalamazoo.
Kalamazoo Nurseries, Kalamazoo.
Kalle Brothers, South Haven.
Katzenberger, Valentine, Bridgeport, R. D.
Keith Brothers Nursery, Sawyer.
Kellogg Co., The R. M., Three Rivers.
Kiger's Nursery, Sawyer.
Knight & Son, David, Sawyer.
Lafler, Cecil W., Bangor.
Lohrman Seed Co., Detroit.
Marvin, O. F., Holton.
Mayer, Jr., Michael, Merrill.
Merrill, W. F., South Haven.
Michigan Nursery Co., Monroe.
Montgomery, W. H., Coloma.
Mutual Nurseries Co., Monroe.
Nash, C. C., Three Rivers.
Nelson & Son, J. A., Paw Paw.
Nevins, Elmer H., Ovid, No. 3.
Newell, Reuben, Birmingham.
Niles Nursery Co., The, Niles.
North Side Florist & Nursery Co., Bangor.
Nu-way Nurseries, Lausling.
Orchard Lake Nurseries, Orchard Lake.
Owens, Geo. B., Leslie.
Parney, E. M., Belding.
Pilkinton, Glenn H., Portland.
Pindar, Joseph, Detroit.
Pitcher, W. D., Buchanan.
Pontiac Nursery Company, Detroit.
Potter, E. W., Leslie.
Prestage, J. G., Allegan.
Prudential Nursery Co., Kalamazoo.
Quandt, Elmer, Dearborn.
Rambo, Lawrence J., Bridgman.
Rasmussen, R. J., Marlette.
Retz, Mathias, Riverside.
Reynolds, Claude, Armada.
Rhodes, A. A. and N. M., Jackson.
Rice, Miss Greta B., Port Huron.
Rokely, J. N., Bridgman.
St. Joseph Nursery, The, St. Joseph.
Sailer, Harry E., Lausling.
Schenck, Geo. H., Elsie.
Shepard, Chas. E., Bangor.
Smith, Henry, Grand Rapids.
Spielman Brothers, Adrian.
Stanley, C. H., Bangor.
Swank, J. C., Dowagiac.
Sweet, L. H., Carsonville.
Taft, H. A., South Haven.

Tindall, W. F., Boyne City.
Ulrich, J. D., Three Rivers.
Von Boeslager, August, Mt. Clemens.
Ward, Paul L., Hillsdale.
Weller Nurseries, Holland.
Weston, A. R. & Co., Bridgman.
Whitten, C. E., Bridgman.
Williams Brothers, Bridgman.
Wise, Ralph, Plainwell.
Witbeck, F. M. & Son, Millburg.
Wolcott Nurseries, Jackson.
Wolverine Detroit Nurseries, Detroit.
Woolf, Mrs. Filena, Allegan.

Michigan Dealers in Nursery Stock.

Asman & Dunn, Detroit.
Benton Harbor Nursery Co., Benton Harbor.
Boyd, Joseph B., Traverse City.
Buskirk, C. M., Big Rapids.
Cross, Eli, Grand Rapids.
Crowley-Milner Company, Detroit.
Cukerski, Wencel L., Grand Rapids.
Derrickson, Henry, Coldwater.
Detroit Shade Tree Co., Detroit.
Filer, A. C., 824 Trenton St., Detroit.
Fox, A. W., Coldwater.
Freyling & Mendels, Grand Rapids.
Gibson, S. B. & Son., Detroit.
Grohman, The Florist, Saginaw.
Gunther, Edmund E., Ann Arbor.
Hartford Canning Co., Hartford.
Harris Seed Company, Ann Arbor.
Healy, William, Bloomingdale.
Heilscher, William E., 760 Milwaukee Ave., Detroit.
Hotchkiss, Caleb J., 903 Seyburn Ave., Detroit.
Hudson, Co., J. L., Detroit.
Hughes, Chas. P., Hillsdale.
Husted & Co., N. P., Lowell.
Isbell & Co., S. M., Jackson.
Jones Sons & Co., J. R., Kalamazoo.
Knapp, W. F., Monroe.
Knoch, Mrs. Gus, 2453 Fort St., W., Detroit.
Kresge Co., S. S., Detroit.
Maire, Lincoln, 2090 Jefferson Ave., E., Detroit.
Nelson, C. A., Northport.
Oakland Gardens Nursery, Walled Lake.
Rayl Co., T. B., Detroit.
Smith & Company, E. M., 20 Hooker Ave., Detroit.
Steffe, Reinhold, Bay City.
Strittmatter, Adolph, 444 Field Ave., Detroit.
Trankla, Chas. & Co., Grand Rapids.

Traver & Clover, Paw Paw.
Valley City Nurseries, Grand Rapids.
Van Aken Brothers, Coldwater.
VanBochove & Brother, G., Kalamazoo.
Vogt, David & Son., Coldwater.
Wardell, L. B., Lansing.
Walther's Department Store, Bay City.
Webb, D. S. & Co., Traverse City.
Westgate Nursery Co., H. L., Monroe.
Woolworth, F. W. & Co., Buffalo, N. Y.

FOREIGN NURSERIES LICENSED IN MICHIGAN.

Allen Nursery Co., Rochester, N. Y.
Barry Nursery Co., Rochester, N. Y.
Bogue, Dewane, Batavia, N. Y.
Brown Brothers Company, Rochester, N. Y.
Bryant, Arthur & Son, Princeton, Ill.
Burr & Company, C. R., Manchester, Conn.
Central New York Nursery Co., Geneva, N. Y.
Charlton Nursery Co., Rochester, N. Y.
Chase Brothers Co., Rochester, N. Y.
Chase Nurseries, The, Geneva, N. Y.
Davis Nursery Co., Franklin, Baltimore, Md.
Dreer, Henry A., Inc., Philadelphia, Penna.
Elm City Nursery Co., New Haven, Conn.
Emmons & Co., Newark, N. Y.
Empire State Nursery Co., Waterloo, N. Y.
Fairview Nurseries, The, Rochester, N. Y.
First National Nurseries, Rochester, N. Y.
Fruit Growers' Nurseries, Newark, N. Y.
Geneva Nursery Co., Geneva, N. Y.
Graham Nursery Co., Rochester, N. Y.
Grover & Co., Frederic E., Rochester, N. Y.
Guaranty Nursery Co., Rochester, N. Y.
Hawks Nursery Co., Wauwatosa, Wis.
Heath & Co., Manchester, Conn.
Hooker Brothers, Rochester, N. Y.
Howe-Campbell Nursery Co., Rochester, N. Y.
Jewell Nursery Co., Lake City Minn.
Knight & Bostwick, Newark, N. Y.
LaPointe Nursery Co., Geneva, N. Y.
Moon Co., Wm. H., Morrisville, Penna.
Moore & Co., Wm. C., Newark, N. Y.
Nelson & Sons, Swain, Chicago, Ill.
Pennsylvania Nursery Co., Girard, Penna.
Perry Nursery Co., Rochester, N. Y.
Rice Brothers Co., Geneva, N. Y.
Sonderegger Nursery and Seed House, Beatrice, Nebr.
Stark Brothers' Nurseries & Orchards Co., Louisiana, Mo.
Stuart & Company, C. W., Newark, N. Y.
Taylor & Co., H. S., Rochester, N. Y.

Weeks Nursery Co., Inc., C. H., Lyons, N. Y.
Western New York Nursery Co., Rochester, N. Y.
Westminster Nursery, The, Westminster, Md.
Wisconsin Nurseries, Union Grove, Wisconsin.

Respectfully submitted,

L. R. TAFT,
State Inspector of Nurseries and Orchards.

East Lansing, Michigan, June 30, 1920.

ANNUAL REPORT OF THE LIBERAL ARTS COUNCIL,

For year ending June 30, 1920.

To the President and Members of the State Board of Agriculture:

By a resolution of the State Board of Agriculture, a Liberal Arts Council was organized in 1915. The resolution provided that three members of the faculty, and two members of the student body, should constitute a council for the promotion of social and general intellectual culture. The same resolution provided that an assessment of \$1.00 per year upon the students, should be collected for the purpose of carrying on the work.

During the current year, the council has consisted of the following:

(a) Student Members

L. S. Palmer
C. O. DeVries

(b) Faculty Members:

W. W. Johnston
C. P. Halligan
W. H. French

During the year we arranged for eight (8) lectures and entertainments by the following persons:

November 18, Rev. A. M. Rihbany, Boston.

December 7, Dr. Ralph Dennis, Evanston.

January 14, Burnell Ford, New York.

January 27, Dr. W. C. Bagley, Columbia Univ., N. Y.

February 12, Hon. W. W. Ellsworth, New York.

March 2, Vachel Lindsay, Boston.

April 8, College Glee Club, E. Lansing.

April 19, Ellis Parker Butler, New York.

On account of an outbreak of influenza, it was necessary to cancel the lectures by Mr. Ellsworth and Mr. Lindsay.

The Council has been greatly handicapped during the year because of the lack of a proper place to hold these entertainments. We have used the armory, the engineering lecture room and the gymnasium, none of which are suitable places, and we have had considerable difficulty to secure even the use of these places.

The lectures given were of high class and made an impression upon the student body, but we are anxious that arrangements shall be made

for a suitable room which will accommodate the student body. It is not fair to the students to assess them for this purpose and then be obliged to hold the entertainment in a place like the engineering lecture room where only about 300 can be accommodated. In our judgment, it would be wise to discontinue this plan until such time as suitable accommodations can be provided.

We append herewith, a financial statement showing the uses of the funds during the year.

Respectfully submitted
W. H. FRENCH.
W. W. JOHNSTON.
C. P. HALLIGAN.

RECEIPTS AND DISBURSEMENTS—COMMITTEE ON LIBERAL ARTS.

School Year 1919-1920.

RECEIPTS.

June 30, 1919, Balance on hand	\$146.44
Student fees	1,284.57
Gate receipts	37.50

DISBURSEMENTS.

June 30, 1920, Refund to students	\$1.01
Labor	17.30
Entertainment	787.16
Printing	26.00
M. A. C. Union	78.00
Miscellaneous	21.50
Balance on hand	537.54
	<hr/>
	\$1,468.51
	<hr/>
	\$1,468.51

REPORT OF MICHIGAN WEATHER SERVICE.

The policy of operation and administration of the Michigan Weather Service has continued as in former years.

Owing to the prevalent condition of lack of man power it has at times been very difficult to keep up all of the voluntary observation work throughout the State.

For the same reason the distribution of the daily forecasts through cooperation with the various telephone companies of the State has been somewhat abridged. Telephone wires and telephone employees are generally working at peak loads most of the time. For the past few years the number of telephone employees has not greatly increased, and telephone equipment has not been amplified. On the other hand the amount of business has greatly increased and it is quite natural that free forecast distribution suffered under these conditions.

The number of voluntary observation stations has, however, not decreased materially, and the work of the voluntary observers has as a rule been of a high order.

Owing to the increased cost of material and the labor of printing, the *Monthly Bulletin* has been abridged by cutting out the monthly charts, the title page, and the remarks of observers. This has brought the bulletin down to the very minimum of what it should possibly be as a publication of record.

Even with this saving in printing it is doubtful whether the budget appropriation will be enough for the bare needs of the service up to and including June 30, 1921.

The weekly *Weather and Crop Bulletins* have continued to be issued during the planting, growing and harvesting season. These bulletins are distributed to a considerable mailing list, besides being published in daily and weekly newspapers.

The administrative work of the office has continued to increase on account of much heavier call for all sorts of meteorological information. This office is very frequently consulted by prospective farm buyers and many requests come from power companies in connection with water power developments. Besides these there are almost countless requests for information in railroad claim settlements, legal controversies involving the condition of the weather and the latest inquiry in the office that has been answered has been in connection with the location of a ranch for the propagation of fur bearing animals.

In fact a detailed report on the various kinds of meteorological data furnished would show that our records are consulted by almost every kind of commercial and agricultural activity in the State, and fully justifies the very meager appropriation which is granted by the State.

C. F. SCHNEIDER,

Director.

Grand Rapids, Mich., June 30, 1920

REPORT OF THE DEPARTMENT OF METEOROLOGY.

WEATHER BUREAU.

Dr. Frank S. Kedzie,

President, Michigan Agricultural College,

Dear Sir: Regarding the work done by the Department of Meteorology during the fiscal year just closed, I beg to state that the usual course in meteorology was conducted for junior and senior agricultural students during the spring term of 1920.

This is a five credit subject, consisting of three lectures and four hours of laboratory work per week.

Very respectfully,

D. A. SEELEY,

Instructor in Meteorology.

East Lansing, Mich., June 30, 1920.

METEOROLOGICAL TABLES.

METEOROLOGICAL TABLES.

Monthly Meteorological Summary, Lansing, Michigan, July, 1919.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1	91	55	73	0	Clear	100	1863		
2	93	61	77	0	Clear	100	1864	71.5	1.25
3	91	63	77	0	Clear	100	1865	65.6	3.91
4	92	68	80	0	Clear	97	1866	71.7	4.10
5	86	62	74	0.04	Cloudy	54	1867	71.6	1.78
6	80	57	68	0	Clear	88	1868	77.2	1.11
7	79	52	66	0	Clear	100	1869	70.4	5.77
8	80	48	64	0	Partly Cloudy	86	1870	74.4	8.02
9	91	58	74	0.05	Partly Cloudy	66	1871	70.6	3.10
10	77	50	64	0	Clear	97	1872	74.9	3.39
11	78	42	60	0	Clear	100	1873	70.8	5.12
12	84	58	71	0.54	Partly Cloudy	56	1874	72.0	2.56
13	86	57	72	0	Partly Cloudy	77	1875	69.7	2.43
14	91	68	80	0.13	Cloudy	49	1876	72.5	2.16
15	83	56	70	0	Partly Cloudy	67	1877	71.4	2.25
16	81	51	66	0	Clear	98	1878	73.0	2.96
17	86	55	70	0	Clear	100	1879	74.0	2.19
18	89	57	73	0	Clear	100	1880	68.0	6.27
19	91	59	75	0	Partly Cloudy	88	1881	73.1	1.81
20	84	63	74	0.06	Cloudy	3	1882	67.5	2.32
21	87	63	75	0.06	Partly Cloudy	28	1883	68.9	11.27
22	85	57	71	0	Clear	92	1884	68.0	2.60
23	89	56	72	T.	Partly Cloudy	68	1885	72.7	2.52
24	87	61	74	0	Clear	100	1886	70.7	6.65
25	89	57	73	0	Partly Cloudy	72	1887	75.5	1.50
26	95	72	84	0.30	Partly Cloudy	61	1888	70.5	2.49
27	93	71	82	0.20	Clear	100	1889	70.2	3.41
28	88	66	77	0.11	Clear	100	1890	71.1	0.92
29	85	58	72	0	Clear	100	1891	65.3	1.88
30	84	57	70	0.17	Cloudy	58	1892	70.3	2.00
31	75	66	70	0.06	Cloudy	21	1893	71.5	1.86
							1894	73.2	0.86
							1895	70.5	1.47
							1796	71.8	6.73
							1897	73.8	8.49
							1898	70.0	1.34
							1899	69.8	2.11
							1900	69.6	4.15
							1901	74.2	5.08
							1902	70.6	7.13
							1903	67.9	3.79
							1904	69.2	1.97
							1905	69.8	5.75
							1906	70.8	2.23
							1907	70.0	4.30
							1908	73.2	1.03
							1909	70.0	2.56
							1910	71.0	1.53
							1911	71.3	1.65
							1912	69.6	5.06
							1913	70.8	2.85
							1914	71.0	1.65
							1915	67.9	5.17
							1916	76.1	0.99
							1917	70.0	3.06
							1918	69.2	1.96
							1919	72.4	1.69
Mean highest temperature..... 86.1									
Mean lowest temperature..... 58.8									
Mean temperature for month..... 72.4									
Total precipitation for month..... 1.69									
WEATHER.									
Number days clear..... 36									
Partly cloudy..... 10									
Cloudy..... 5									
With 0.01 or more of precipitation..... 11									
SUNSHINE.									
Number hours sunshine..... 364.3									
Possible hours sunshine..... 464.9									
Percentage of possible..... 78									

BAROMETER—Mean, 29.99 inches; highest 30.27 inches, on 1st; lowest, 29.74 inches, on 10 h.

TEMPERATURE—Highest, 95°, on 26th; lowest, 42°, on 11th; greatest daily range, 36°, on 1st; least daily range, 9° on 31st; normal for month, 70.9°; excess or deficiency this month, +1.5°; accumulated excess or deficiency since January 1st, +463°; average daily, same period, +2.2°; highest in 34 years, 102°; lowest, 37°.

PRECIPITATION—(In inches)—Total amount, 1.69; normal, 3.22; excess or deficiency this month, -1.53; since January 1st, -0.48. Greatest amount in any 24 hour period, 0.51, on 12th. Total snowfall, 0.0 in.

WIND—Prevailing direction, southwest. Total movement, 3,292 miles; average hourly velocity, 4.4 miles. Maximum velocity 26, from the northwest, on 9th.

DATES OF—Auroras, 22; fog, dense, 0; hail, 26; thunderstorms, 5, 9, 12, 11, 20, 21, 26, 27, 28. Halos: solar 14, 25, 29; lunar, 0. Frost: killing, 0; heavy, 0; light, 11.

DEWEY A. SEELEY,
Meteorologist.

Monthly Meteorological Summary, Lansing, Michigan, August, 1919.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.			
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.	
1	77	52	64	0	Partly Cloudy	67	1863	.....	3
2	77	49	63	0	Partly Cloudy	96	1864	70.7	0.39	
3	82	52	67	T.	Partly Cloudy	74	1865	65.8	3.38	
4	83	61	72	2 19	Partly Cloudy	48	1866	62.6	3.44	
5	76	68	72	0 35	Cloudy	15	1867	69.8	1.74	
6	86	68	77	0	Partly Cloudy	73	1868	70.3	2.42	
7	85	60	72	0	Partly Cloudy	100	1869	70.6	4.85	
8	69	51	60	0	Partly Cloudy	63	1870	70.1	4.53	
9	74	48	61	0	Clear	100	1871	71.2	1.42	
10	78	49	64	0	Clear	93	1872	71.2	4.18	
11	81	53	67	0	Partly Cloudy	79	1873	69.5	0.80	
12	82	60	71	0	Partly Cloudy	78	1874	69.4	1.28	
13	78	60	69	T.	Cloudy	28	1875	65.5	1.47	
14	86	62	74	T.	Partly Cloudy	86	1876	71.6	1.28	
15	87	59	73	T.	Partly Cloudy	61	1877	68.5	6.57	
16	77	62	70	0 66	Partly Cloudy	45	1878	70.2	1.85	
17	77	59	68	0 01	Partly Cloudy	52	1879	70.0	1.61	
18	76	58	67	0 07	Cloudy	36	1880	68.6	6.02	
19	81	58	70	0	Clear	91	1881	72.7	1.63	
20	85	55	70	0 02	Partly Cloudy	72	1882	69.5	5.72	
21	79	58	68	0 08	Clear	79	1883	64.9	0.18	
22	85	56	70	0	Clear	100	1884	66.9	1.30	
23	87	60	74	0	Clear	86	1885	63.6	6.75	
24	79	56	68	0	Partly Cloudy	71	1886	69.3	4.69	
25	74	49	62	0	Clear	95	1887	68.0	0.89	
26	75	49	62	0 04	Partly Cloudy	81	1888	67.6	1.87	
27	70	48	59	0	Cloudy	54	1889	68.6	0.68	
28	76	47	62	0	Partly Cloudy	73	1890	65.4	3.60	
29	81	45	63	0 58	Partly Cloudy	84	1891	67.9	4.82	
30	78	56	67	0	Partly Cloudy	89	1892	68.3	5.12	
31	74	50	62	0 03	Partly Cloudy	59	1893	68.1	0.56	
							1894	68.8	0.00	
							1895	71.2	4.64	
							1896	70.0	4.73	
							1897	65.9	1.69	
Mean highest temperature.....							79.2	1898	69.0	2.73
Mean lowest temperature.....							55.4	1899	71.4	0.70
Mean temperature for month.....							67.3	1900	73.3	2.98
Total precipitation for month.....							4.03	1901	68.4	2.49
WEATHER.										
Number days clear.....							7	1902	64.2	0.68
Partly cloudy.....							20	1903	64.3	6.73
Cloudy.....							4	1904	65.9	3.26
With 0.01 or more of precipitation.....							19	1905	69.6	3.92
							1906	73.5	4.35	
							1907	65.5	2.87	
							1908	68.4	3.99	
							1909	71.0	1.61	
							1910	68.2	1.76	
							1911	68.2	1.18	
							1912	65.7	2.19	
							1913	69.4	5.60	
							1914	68.9	3.33	
							1915	63.4	4.63	
							1916	71.0	1.58	
Number hours sunshine.....							309.1	1917	67.0	1.47
Possible hours sunshine.....							430.7	1918	72.2	1.44
Percentage of possible.....							72	1919	67.3	4.03

BAROMETER—Mean, 29.94 inches; highest, 30.28 inches, on 11th; lowest, 29.69 inches, on 21st.
 Temperature—Highest, 87°, on 23d; lowest, 45°, on 29th; greatest daily range, 36°, on 29th; least daily range, 8°, on 5th.
 Normal for month, 68.4°; excess of deficiency this month, -1.1°. Accumulated excess or deficiency since January 1st, +132°;
 average daily, same period, +1.8°; highest in 34 years, 102°; lowest, 32°.

PRECIPITATION (in inches)—Total amount, 4.03; normal, 2.63; excess or deficiency this month, +1.40; since January 1st, +0.92. Greatest amount in any 24 hour period, 2.22, on 4th and 5th. Total snowfall, 0.0 inches.

WIND—Prevailing direction, southwest. Total movement, 3,301 miles; average hourly velocity, 4.4 miles. Maximum velocity, 18, from the northwest on 25th.

DATES OF—Auroras, 18, 19; fog, dense, 5, 13, 18; hail, 0; thunderstorms, 4, 5, 13, 16, 17, 18, 20, 29; halos, solar, 2, 6, 11, 29; lunar, 0; frost: killing, 0; heavy, 0; light, 0.

DEWEY A. SEELEY,
 Meteorologist.

Monthly Meteorological Summary, Lansing, Michigan, September, 1919.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1.....	77	45	61	0	Clear.....	95	1863	.....	0 89
2.....	77	45	61	0	Partly Cloudy ..	89	1864	59 6	3 53
3.....	81	52	66	0	Partly Cloudy ..	60	1865	67 7	4 79
4.....	77	53	65	0 01	Clear.....	84	1866	55 8	5 80
5.....	80	46	63	0	Partly Cloudy ..	82	1867	56 6	1 42
6.....	88	65	76	0	Partly Cloudy ..	72	1868	58 8	2 95
7.....	88	66	77	0	Partly Cloudy ..	68	1869	63 5	1 43
8.....	90	70	80	0	Partly Cloudy ..	77	1870	63 7	2 85
9.....	86	65	76	T.	Partly Cloudy ..	50	1871	59 1	0 79
10.....	70	60	65	0 21	Cloudy.....	2	1872	62 0	5 21
11.....	75	51	63	0 01	Partly Cloudy ..	61	1873	67 4	3 50
12.....	71	46	58	0	Clear.....	99	1874	62 8	1 27
13.....	76	42	59	0	Clear.....	100	1875	58 5	2 89
14.....	73	49	61	0 01	Cloudy.....	7	1876	56 3	3 65
15.....	80	54	67	0	Partly Cloudy ..	74	1877	61 3	1 38
16.....	76	49	62	0	Partly Cloudy ..	77	1878	63 2	3 41
17.....	74	49	62	0	Partly Cloudy ..	85	1879	56 2	3 19
18.....	76	50	63	0 01	Cloudy.....	27	1880	55 8	3 10
19.....	73	61	67	0 39	Cloudy.....	3	1881	69 7	2 91
20.....	83	59	71	0 43	Cloudy.....	41	1882	59 9	0 67
21.....	73	62	68	0 54	Cloudy.....	0	1883	56 4	2 34
22.....	71	54	62	0	Partly Cloudy ..	67	1884	56 1	3 34
23.....	69	48	58	0	Partly Cloudy ..	84	1885	58 9	3 75
24.....	69	50	60	0	Clear.....	100	1886	62 1	5 40
25.....	61	39	50	0	Partly Cloudy ..	93	1887	58 9	4 72
26.....	63	34	48	0	Clear.....	100	1888	57 8	1 89
27.....	78	48	63	0	Clear.....	100	1889	61 2	0 79
28.....	81	52	66	0 02	Cloudy.....	92	1890	57 7	1 67
29.....	75	52	64	0 69	Cloudy.....	69	1891	65 1	1 10
30.....	52	48	50	0 29	Cloudy.....	0	1892	60 8	2 17
31.....							1893	58 4	1 81
							1894	63 7	2 59
							1895	66 6	0 85
							1896	57 6	6 73
							1897	62 9	0 80
							1898	63 3	3 00
							1899	57 0	2 14
							1900	63 2	0 89
							1901	61 7	1 67
							1902	58 7	5 88
							1903	61 0	2 86
							1904	62 0	2 35
							1905	63 8	3 21
							1906	67 5	0 76
							1907	61 8	4 68
							1908	66 4	0 65
							1909	60 4	1 51
							1910	60 2	2 74
							1911	61 5	5 05
							1912	62 7	3 33
							1913	61 0	1 53
							1914	60 3	2 65
							1915	63 2	6 53
							1916	60 4	2 17
							1917	58 6	4 60
							1918	54 2	2 88
							1919	63 8	2 61
Mean highest temperature.....						75 4			
Mean lowest temperature.....						52 1			
Mean temperature for month.....						63 8			
Total precipitation for month.....						2 61			
WEATHER.									
Number days clear.....						7			
Partly Cloudy.....						14			
Cloudy.....						9			
With 0.01 or more of precipitation.....						16			
SUNSHINE.									
Number of hours sunshine.....						246 3			
Possible hours sunshine.....						374 8			
Percentage of possible.....						66			

BAROMETER—Mean, 30.02 inches; highest, 30.30 inches, on 30th; lowest, 29.41 inches, on 19th.

TEMPERATURE—Highest, 90°, on 8th; lowest, 34°, on 26th; greatest daily range, 34°, on 13th. Least daily range, 4°, on 30th. Normal for month, 61.6°; excess or deficiency this month, +2.2°; accumulated excess or deficiency since January 1st, +496°; average daily, same period, +1.8°; highest in 34 years, 99°; lowest, 21°.

PRECIPITATION (in inches)—Total amount, 2.61; normal, 2.62; excess or deficiency this month, -0.01; since January 1st, -0.91. Greatest amount in any 24 hour period, 0.96, on 20th and 21st. Total snowfall, 0.0 inch.

WIND—Prevailing direction, southwest; total movement, 3,677 miles; average hourly velocity, 5.1 miles; maximum velocity 23, from the south on 19th.

DATES OF—Auroras, 19, 23; fog, dense, 0; hail, 0; thunderstorms, 20, 21, 28, 29; halos: solar 2, 6, 20, 28; lunar, 0; frost: killing, 0; heavy, 0; light, 13, 26.

DEWEY A. SEELEY,
Meteorologist.

Monthly Meteorological Summary, Lansing, Michigan, October, 1919.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1	60	48	54	0 01	Cloudy.....	0	1863		1 04
2	84	60	72	0	Clear.....	100	1864	45 7	1 86
3	83	61	72	0	Partly Cloudy.....	88	1865	46 5	2 76
4	83	58	70	0 01	Partly Cloudy.....	91	1866	49 5	3 57
5	75	62	68	0 10	Cloudy.....	38	1867	50 6	2 11
6	67	52	60	0	Clear.....	100	1868	45 2	1 11
7	59	39	49	0	Clear.....	91	1869	40 8	1 72
8	64	36	50	0	Clear.....	100	1870	52 5	2 29
9	75	54	64	0 07	Partly Cloudy.....	47	1871	53 9	1 43
10	75	48	62	0 40	Cloudy.....	19	1872	47 4	0 67
11	53	33	43	0	Partly Cloudy.....	51	1873	44 7	1 91
12	57	29	43	0	Clear.....	100	1874	49 1	0 49
13	62	36	49	0	Clear.....	91	1875	42 9	5 81
14	67	45	56	T.	Partly Cloudy.....	63	1876	43 7	1 26
15	61	41	52	0 01	Cloudy.....	59	1877	50 8	5 69
16	52	34	43	0 66	Cloudy.....	3	1878	48 3	1 99
17	54	30	42	0	Partly Cloudy.....	90	1879	57 3	1 57
18	58	31	44	0	Partly Cloudy.....	60	1880	46 2	2 84
19	54	23	41	0	Partly Cloudy.....	85	1881	52 5	5 56
20	56	28	42	0 03	Partly Cloudy.....	85	1882	52 7	2 64
21	53	45	49	0 01	Cloudy.....	0	1883	46 2	3 66
22	59	42	50	0 01	Partly Cloudy.....	72	1884	50 9	5 73
23	63	42	52	0	Cloudy.....	0	1885	45 0	3 08
24	71	48	60	0	Partly Cloudy.....	68	1886	52 4	0 95
25	75	53	64	0 13	Cloudy.....	37	1887	45 0	1 86
26	53	43	48	0 15	Cloudy.....	12	1888	45 7	3 00
27	59	41	50	0 23	Cloudy.....	0	1889	44 2	0 65
28	57	34	46	0 02	Cloudy.....	10	1890	49 1	4 56
29	52	30	41	0 13	Partly Cloudy.....	88	1891	48 8	0 82
30	69	43	56	0 72	Cloudy.....	38	1892	48 3	0 78
31	68	45	56	0 81	Cloudy.....	0	1893	49 7	3 61
							1894	49 8	1 91
							1895	45 0	1 41
							1896	44 6	1 06
							1897	53 1	2 15
Mean highest temperature.....						63 9	1898	49 6	3 55
Mean lowest temperature.....						42 7	1899	53 2	2 68
Mean temperature for month.....						53 3	1900	56 6	2 77
Total precipitation for month.....						2 90	1901	49 6	4 61
							1902	49 6	1 53
							1903	51 0	2 01
							1904	48 6	1 90
							1905	50 9	1 75
							1906	49 2	2 36
							1907	46 0	2 22
Number days clear.....						6	1908	51 9	0 82
Partly cloudy.....						12	1909	46 2	0 71
Cloudy.....						13	1910	51 8	2 27
With 0.01 or more of precipitation.....						17	1911	48 0	5 00
							1912	50 4	3 44
							1913	50 2	3 30
							1914	54 6	2 81
							1915	51 1	0 70
							1916	49 7	2 53
Number hours sunshine.....						188 1	1917	41 2	3 44
Possible hours sunshine.....						341 9	1918	52 6	3 21
Percentage of possible.....						55	1919	53 3	2 90

BAROMETER—Mean, 30.06 inches; highest, 30.38 inches, on 19th; lowest, 29.61 inches, on 28th.

TEMPERATURE—Highest, 84°, on 2d; lowest, 28°, on 20th; greatest daily range, 28°, on 8th; least daily range, 8°, on 21st; normal for month, 49.0°; excess or deficiency this month, +4.3°; accumulated excess or deficiency since January 1, +627°; average daily, same period, +2.1°; highest in 34 years, 90°, lowest, 10°.

PRECIPITATION (in inches)—Total amount, 2.90; normal, 2.23; excess or deficiency this month, +0.67; since January 1st, +1.58. Greatest amount, in any 24 hour period, 0.97, on 30th and 31st. Total snowfall, 0.0 inches.

WIND—Prevailing direction, southwest; total movement, 4,155 miles; average hourly velocity, 5.6 miles. Maximum velocity 24 from the southeast on 27th.

DATES OF—Auroras, 22; fog, dense, 15; hail, 0; thunderstorms, 2, 4, 5, 10, 31; halos: solar, 11, 29; lunar, 0; frost: killing, 12; heavy, 0; light, 8.

DEWEY A. SEELEY,
METEOROLOGIST.

Monthly Meteorological Summary, Lansing, Michigan, November, 1919.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1.....	45	32	38	0	Cloudy.....	25	1863		0 40
2.....	50	27	38	0	Clear.....	100	1864	37 9	4 12
3.....	50	38	44	T.	Cloudy.....	30	1865	38 6	0 68
4.....	46	32	39	0 27	Cloudy.....	13	1866	37 9	2 60
5.....	41	29	35	0	Cloudy.....	47	1867	40 4	1 77
6.....	46	28	37	T.	Partly Cloudy ..	60	1868	36 8	2 44
7.....	48	35	42	0 18	Cloudy.....	35	1869	32 1	1 93
8.....	41	38	40	0	Cloudy.....	0	1870	38 4	0 91
9.....	53	39	46	0	Partly Cloudy ..	32	1871	32 0	1 25
10.....	55	45	50	0 23	Cloudy.....	0	1872	29 8	0 98
11.....	50	33	42	0	Partly Cloudy ..	79	1873	28 5	2 03
12.....	48	24	36	T.	Partly Cloudy ..	45	1874	35 0	1 61
13.....	27	21	24	0 03	Cloudy.....	15	1875	33 0	1 11
14.....	38	18	28	0	Partly Cloudy ..	80	1876	36 3	0 91
15.....	37	15	26	0	Partly Cloudy ..	100	1877	35 2	3 67
16.....	48	31	40	T.	Cloudy.....	82	1878	36 3	2 16
17.....	57	38	48	0	Clear.....	94	1879	38 2	4 55
18.....	42	28	35	0 01	Cloudy.....	41	1880	27 5	2 32
19.....	32	20	26	T.	Cloudy.....	9	1881	38 2	4 09
20.....	43	18	30	0	Partly Cloudy ..	68	1882	36 3	1 83
21.....	51	37	44	0 06	Cloudy.....	51	1883	38 1	3 98
22.....	46	36	41	0 02	Partly Cloudy ..	53	1884	34 1	1 84
23.....	44	29	36	0	Partly Cloudy ..	63	1885	37 2	2 90
24.....	41	28	34	T.	Cloudy.....	57	1886	33 9	1 48
25.....	40	27	34	0 14	Cloudy.....	0	1887	35 7	2 28
26.....	27	20	24	T.	Cloudy.....	0	1888	38 5	3 12
27.....	24	20	22	0 06	Cloudy.....	0	1889	37 4	2 67
28.....	34	23	28	0 05	Cloudy.....	0	1890	39 1	2 30
29.....	57	25	41	1 32	Cloudy.....	0	1891	34 0	3 34
30.....	25	20	22	0 07	Cloudy.....	0	1892	34 2	1 84
31.....							1893	31 6	2 19
							1894	32 5	0 97
							1895	35 4	3 87
							1896	37 1	1 05
							1897	36 5	2 94
							1898	33 1	2 72
							1899	39 7	1 72
							1900	35 3	5 10
							1901	32 8	1 21
							1902	43 0	2 46
							1903	34 0	1 45
							1904	40 0	0 04
							1905	35 8	2 25
							1906	37 0	2 66
							1907	36 0	1 83
							1908	38 2	1 82
							1909	44 5	3 74
							1910	34 0	1 37
							1911	33 8	3 40
							1912	38 6	2 86
							1913	41 7	2 38
							1914	37 6	1 40
							1915	39 8	2 23
							1916	38 8	1 68
							1917	35 8	0 82
							1918	40 4	3 22
							1919	35 7	2 41
Mean highest temperature.....						42 9			
Mean lowest temperature.....						28 5			
Mean temperature for month.....						35 7			
Total precipitation for month.....						2 41			
WEATHER.									
Number days clear.....						2			
Partly cloudy.....						9			
Cloudy.....						19			
With 0.01 or more of precipitation.....						12			
SUNSHINE.									
Number hours sunshine.....						115 4			
Possible hours sunshine.....						292 1			
Percentage of possible.....						39			

BAROMETER—Mean, 30.07 inches; highest, 30.54 inches, on 20th; lowest, 28.93 inches, on 29th.

TEMPERATURE—Highest, 57°, on 17th; lowest, 15°, on 15th; greatest daily range, 32°, on 29th; least daily range, 3°, on 8th; normal for month, 36.8°; excess of deficiency this month, -1.1°; accumulated excess or deficiency since January 1st, +593° average daily, same period, +1.70°; highest in 34 years, 72°; lowest, 0°.

PRECIPITATION (in inches)—Total amount, 2.44; normal, 2.41; excess or deficiency this month, +0.3; since January 1st, +1.59. Greatest amount in any 24 hour period, 1.34, on 28th and 29th. Total snowfall, 3.1 inches.

WIND—Prevailing direction, west; total movement, 6,063 miles; average hourly velocity, 8.4 miles. Maximum velocity, 35, from the southwest, on 29th.

DATES OF—Auroras, 0; fog, dense, 0; hail, 0; thunderstorms, 0; halos: solar, 1, 6, 15, 20, 21; lunar, 2; frost: killing, 00 heavy, 0; light, 0.

DEWEY A. SEELEY,
METEOROLOGIST.

Monthly Meteorological Summary, Lansing, Michigan, December, 1919.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1	23	17	20	0.04	Cloudy	16	1863		1.71
2	20	4	12	0.02	Partly Cloudy	79	1864	24.4	3.20
3	22	2	12	T.	Partly Cloudy	48	1865	26.7	1.43
4	30	10	20	0	Clear	100	1866	25.5	1.90
5	30	24	27	T.	Cloudy	0	1867	25.3	1.34
6	30	24	27	0.45	Cloudy	0	1868	21.2	1.35
7	32	24	28	0.02	Cloudy	38	1869	28.2	2.11
8	27	20	24	0	Cloudy	42	1870	24.8	2.57
9	31	20	26	0.10	Cloudy	0	1871	21.1	1.76
10	20	0	10	0.02	Partly Cloudy	75	1872	15.7	1.06
11	30	2	14	T.	Cloudy	25	1873	29.5	3.02
12	43	27	35	0	Cloudy	59	1874	27.0	0.37
13	35	14	24	T.	Cloudy	7	1875	31.6	2.80
14	16	10	13	0.01	Cloudy	6	1876	15.2	1.29
15	14	1	8	0.01	Partly Cloudy	40	1877	36.6	1.03
16	14	2	8	0.08	Cloudy	0	1878	21.3	2.27
17	10	-5	2	0	Clear	100	1879	27.5	3.55
18	15	0	8	0	Cloudy	34	1880	22.1	0.85
19	22	4	13	0	Clear	100	1881	34.3	1.75
20	26	2	14	T.	Partly Cloudy	73	1882	24.8	0.88
21	30	18	24	T.	Cloudy	53	1883	26.4	1.28
22	29	23	26	T.	Cloudy	0	1884	21.7	4.15
23	30	22	26	0.02	Cloudy	0	1885	27.8	2.14
24	29	5	17	T.	Partly Cloudy	69	1886	19.7	1.56
25	28	0	14	T.	Cloudy	4	1887	27.3	3.32
26	37	28	32	T.	Cloudy	0	1888	30.4	1.20
27	33	21	27	0.01	Cloudy	0	1889	36.8	2.61
28	21	6	14	T.	Partly Cloudy	57	1890	26.4	1.12
29	34	7	20	0.07	Cloudy	0	1891	34.6	1.47
30	33	23	28	0	Cloudy	46	1892	25.6	1.52
31	37	21	29	0.01	Partly Cloudy	74	1893	27.6	2.28
							1894	30.1	0.93
Mean highest temperature.....							1895	28.5	5.39
Mean lowest temperature.....							1896	28.1	0.80
Mean temperature for month.....							1897	25.6	2.02
Total precipitation for month.....							1898	24.8	1.42
							1899	25.0	1.51
							1900	26.7	0.50
							1901	21.6	3.00
							1902	24.8	2.89
							1903	19.7	1.75
							1904	21.7	1.42
							1905	30.2	2.54
							1906	26.8	1.85
							1907	22.7	4.19
							1908	26.4	2.08
							1909	23.0	2.91
							1910	21.6	1.28
							1911	31.1	1.58
							1912	31.0	1.20
							1913	31.8	0.55
							1914	21.6	1.57
							1915	24.8	1.01
							1916	22.7	2.11
							1917	19.1	0.74
							1918	32.9	3.61
							1919	19.4	0.86

WEATHER.

Number days clear.....	3
Partly cloudy.....	8
Cloudy.....	20
With 0.01 or more of precipitation.....	13

SUNSHINE.

Number hours sunshine.....	106.6
Possible hours sunshine.....	280.8
Percentage of possible.....	38

BAROMETER—Mean, 30.12 inches; Highest, 30.78 inches, on 10th; lowest, 29.43 inches, on 29th.
 TEMPERATURE—Highest, 43°, on 12th; lowest, -5°, on 17th; greatest daily range, 32°, on 11th; least daily range, 6°, on 6th.
 Normal for month, 26.8°; excess or deficiency this month, -7.4°. Accumulated excess or deficiency since January 1st, +365°;
 average daily, same period, +1.0°; highest in 34 years, 62°, lowest, -21°.

PRECIPITATION (in inches)—Total amount, 0.86; normal, 2.08; excess or deficiency this month, -1.22; since January 1st, +0.39. Greatest amount in any 24 hour period, 0.45, on 6th. Total snowfall, 10.2 inches.

WIND—Prevailing direction, northwest. Total movement, 5,240 miles; average hourly velocity, 7.0 miles; maximum velocity 24, from the northwest, on 29th.

DATES OF—Auroras, 0; fog, dense, 0; hail, 0; thunderstorms, 0; halos: solar, 1, 15, 16, 18, 29, 31; lunar, 0; Frost: killing, — heavy, —; light, —.

DEWEY A. SEELEY,
 METEOROLOGIST.

METEOROLOGICAL TABLES.

149

Monthly Meteorological Summary, Lansing, Michigan, January, 1920.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.			
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.	
1.....	22	1	12	0.05	Cloudy.....	37	1863			
2.....	6	-4	1	0.01	Partly Cloudy ..	75	1864	22.3	0.94	
3.....	10	0	5	0.01	Cloudy.....	18	1865	21.1	0.65	
4.....	14	-5	4	T.	Partly Cloudy ..	56	1866	21.2	2.03	
5.....	22	-5	8	T.	Partly Cloudy ..	64	1867	17.6	1.68	
6.....	29	20	24	0.04	Cloudy.....	0	1868	19.0	1.47	
7.....	33	28	30	0.10	Cloudy.....	0	1869	29.4	0.87	
8.....	29	18	24	T.	Cloudy.....	5	1870	25.4	1.93	
9.....	25	11	18	0.23	Cloudy.....	53	1871	24.8	3.95	
10.....	26	15	20	0	Partly Cloudy ..	63	1872	21.6	0.42	
11.....	30	19	24	T.	Partly Cloudy ..	67	1873	15.9	2.98	
12.....	31	19	26	T.	Cloudy.....	10	1874	27.7	3.53	
13.....	34	16	25	T.	Partly Cloudy ..	71	1875	12.9	1.81	
14.....	16	7	12	T.	Partly Cloudy ..	69	1876	30.2	1.63	
15.....	20	7	14	0.02	Cloudy.....	46	1877	18.1	1.33	
16.....	9	6	8	0.27	Cloudy.....	0	1878	29.1	1.12	
17.....	18	0	9	0.01	Cloudy.....	45	1879	19.2	0.49	
18.....	13	3	8	0.01	Partly Cloudy ..	73	1880	37.1	2.67	
19.....	15	-3	6	0.12	Partly Cloudy ..	59	1881	17.0	2.27	
20.....	16	-1	8	0.03	Cloudy.....	0	1882	21.9	1.17	
21.....	23	-1	10	0	Clear.....	100	1883	14.4	1.53	
22.....	22	-6	8	0	Clear.....	100	1884	15.5	1.23	
23.....	20	8	14	0.41	Cloudy.....	0	1885	15.3	2.70	
24.....	16	-3	6	T.	Partly Cloudy ..	86	1886	18.8	2.66	
25.....	11	-11	-2	0	Clear.....	92	1887	18.2	3.25	
26.....	33	4	18	0	Cloudy.....	46	1888	15.4	2.18	
27.....	30	14	22	0	Cloudy.....	0	1889	28.0	1.53	
28.....	18	-4	7	0	Clear.....	93	1890	31.5	2.31	
29.....	33	10	22	0	Clear.....	100	1891	26.7	0.82	
30.....	30	3	16	0	Cloudy.....	30	1892	19.2	0.96	
31.....	7	-5	1	0	Clear.....	90	1893	14.8	1.78	
							1894	26.9	1.37	
							1895	17.5	1.04	
							1896	24.6	0.79	
							1897	22.3	4.17	
							1898	24.9	3.07	
							1899	21.7	2.03	
							1900	25.6	1.17	
							1901	22.2	1.51	
							1902	20.5	0.43	
							1903	20.7	1.20	
							1904	14.4	2.82	
							1905	18.2	1.07	
							1906	31.8	1.99	
							1907	23.2	3.97	
							1908	23.8	1.89	
							1909	26.6	2.16	
							1910	23.4	2.52	
							1911	25.2	1.43	
							1912	9.2	0.80	
							1913	26.2	3.10	
							1914	27.0	2.98	
							1915	20.4	1.54	
							1916	27.6	3.11	
							1917	21.0	1.55	
							1918	10.2	2.08	
							1919	28.5	0.36	
							1920	13.2	1.34	
Mean highest temperature.....										24.1
Mean lowest temperature.....										5.0
Mean temperature for month.....										13.2
Total precipitation for month.....										1.34
WEATHER.										
Number days clear.....										6
Partly Cloudy.....										10
Cloudy.....										15
With 0.01 or more of precipitation.....										13
SHINE.										
Number hours sunshine.....										142.1
Possible hours sunshine.....										292.5
Percentage of possible.....										49

Monthly Meteorological Summary, Lansing, Michigan, February, 1920.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1.....	30	1	16	0	Cloudy.....	48	1863.....	.....	.....
2.....	48	28	38	0	Cloudy.....	61	1864.....	27 3	0 27
3.....	31	17	24	0 01	Cloudy.....	8	1865.....	27 6	1 76
4.....	26	15	20	0	Cloudy.....	57	1866.....	22 7	2 28
5.....	34	13	24	0	Clear.....	84	1867.....	30 9	3 23
6.....	35	18	26	0	Cloudy.....	62	1868.....	18 7	1 28
7.....	31	27	29	0 01	Cloudy.....	6	1869.....	26 7	2 95
8.....	32	28	30	T.	Cloudy.....	0	1870.....	24 2	1 20
9.....	34	28	31	0 07	Cloudy.....	0	1871.....	25 6	1 73
10.....	30	21	26	0 03	Cloudy.....	12	1872.....	21 3	0 46
11.....	31	17	24	0 01	Cloudy.....	4	1873.....	19 1	0 77
12.....	28	23	26	0 09	Cloudy.....	9	1874.....	25 5	1 55
13.....	31	20	26	0 04	Cloudy.....	31	1875.....	8 0	2 20
14.....	29	12	20	0 05	Cloudy.....	29	1876.....	27 4	3 04
15.....	12	0	6	0 01	Partly Cloudy ..	70	1877.....	32 3	0 00
16.....	22	- 1	10	0 01	Cloudy.....	49	1878.....	28 1	2 74
17.....	29	- 4	16	0 13	Cloudy.....	0	1879.....	20 4	1 43
18.....	20	- 6	7	T.	Cloudy.....	71	1880.....	29 2	1 62
19.....	24	- 8	6	0	Clear.....	100	1881.....	21 6	3 77
20.....	31	- 3	14	0	Partly Cloudy ..	91	1882.....	35 1	2 28
21.....	37	11	24	0	Partly Cloudy ..	89	1883.....	19 8	4 50
22.....	32	15	24	T.	Cloudy.....	64	1884.....	23 4	3 69
23.....	32	24	26	0 27	Cloudy.....	3	1885.....	8 9	0 73
24.....	27	12	20	T.	Partly Cloudy ..	68	1886.....	22 3	1 35
25.....	20	2	11	T.	Partly Cloudy ..	78	1887.....	24 3	5 71
26.....	15	- 4	6	0	Partly Cloudy ..	100	1888.....	22 0	1 70
27.....	22	10	16	0 01	Partly Cloudy ..	65	1889.....	18 3	1 17
28.....	28	8	18	0 06	Cloudy.....	47	1890.....	31 5	1 79
29.....	22	0	11	0 01	Partly Cloudy ..	82	1891.....	26 7	2 20
30.....							1892.....	27 3	1 93
31.....							1893.....	21 3	1 83
							1894.....	21 2	0 53
							1895.....	16 4	0 12
							1896.....	24 3	1 51
							1897.....	26 4	0 67
							1898.....	23 8	1 82
Mean highest temperature.....						28 3	1899.....	16 8	1 51
Mean lowest temperature.....						11 3	1900.....	17 4	3 44
Mean temperature for month.....						19 8	1901.....	12 8	1 83
Total precipitation for month.....						0 81	1902.....	18 6	0 44
							1903.....	20 6	1 58
							1904.....	12 0	3 30
							1905.....	15 8	1 25
							1906.....	23 6	1 12
							1907.....	19 2	0 25
							1908.....	21 6	3 19
Number days clear.....						2	1909.....	28 4	2 36
Partly cloudy.....						8	1910.....	21 9	2 65
Cloudy.....						19	1911.....	27 6	1 77
With 0.01 or more of precipitation.....						15	1912.....	15 8	2 04
							1913.....	20 0	1 65
							1914.....	12 7	0 79
							1915.....	29 4	2 10
							1916.....	19 2	0 69
							1917.....	15 5	0 62
Number hours sunshine.....						148 2	1918.....	21 8	3 04
Possible hours sunshine.....						306 4	1919.....	27 0	1 50
Percentage of possible.....						48	1920.....	19 8	0 81

BAROMETER—Mean, 30.06 inches; highest, 30.68 inches, on 3rd; lowest, 29.46 inches, on 17th.
TEMPERATURE—Highest, 48°, on 2nd; lowest, -8°, on 19th; greatest daily range, 34°, on 20th; least daily range, 4°, on 8th.
Normal for month, 21.6°. Excess or deficiency this month, -1.8°. Accumulated excess or deficiency since January 1st, -348°;
average daily, same period, -5.8°; highest in 35 years, 62°; lowest, -25°.
PRECIPITATION (in inches)—Total amount, 0.81; normal, 2.09; excess or deficiency this month, -1.28; since January 1st,
-2.03. Greatest amount in any 24 hour period, 0.27, on 23rd. Total snowfall, 11.2 inches.
WIND—Prevailing direction, northwest. Total movement, 4,500 miles; average hourly velocity, 6.5 miles. Maximum
velocity 23, from the southwest, on 16th.
DATES OF—Auroras, 0; fog, dense, 0; hail, 0; thunderstorms, 0; halos: solar, 3, 4, 11, 16, 21; lunar, 1, 3, 4, 5; frost: killing, -;
heavy, -; light, -.

DEWEY A. SEELEY,
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METEOROLOGICAL TABLES.

151

Monthly Meteorological Summary, Lansing, Michigan, March, 1920.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1.....	33	14	24	T.	Partly Cloudy	71	1863		
2.....	42	13	28	0	Clear	100	1864	31.7	2.26
3.....	40	10	25	0	Partly Cloudy	81	1865	37.0	2.79
4.....	39	16	28	0.93	Cloudy	0	1866	29.1	3.39
5.....	20	5	12	0.03	Clear	96	1867	29.7	0.68
6.....	18	0	9	0	Partly Cloudy	81	1868	37.8	4.65
7.....	15	6	10	T.	Partly Cloudy	72	1869	27.6	1.65
8.....	28	10	19	0.01	Cloudy	31	1870	30.3	3.01
9.....	42	24	33	0	Cloudy	85	1871	38.2	3.91
10.....	42	33	38	T.	Cloudy	18	1872	24.8	2.04
11.....	47	40	44	0.54	Cloudy	0	1873	28.3	1.73
12.....	50	22	36	0.29	Cloudy	0	1874	32.3	1.79
13.....	25	16	20	0.06	Clear	82	1875	26.2	1.02
14.....	41	15	28	0	Partly Cloudy	97	1876	30.6	1.84
15.....	55	35	45	0.65	Cloudy	62	1877	24.5	5.60
16.....	50	30	40	T.	Partly Cloudy	83	1878	40.9	3.12
17.....	30	20	25	T.	Cloudy	75	1879	33.2	1.57
18.....	40	19	30	0.10	Partly Cloudy	77	1880	35.5	1.70
19.....	31	25	28	0.13	Cloudy	0	1881	30.3	2.66
20.....	46	23	31	0	Clear	92	1882	36.0	3.58
21.....	49	24	36	0	Partly Cloudy	100	1883	24.9	0.71
22.....	63	31	47	0	Clear	100	1884	29.9	3.67
23.....	66	38	52	0	Partly Cloudy	100	1885	21.3	0.58
24.....	65	43	51	0	Cloudy	85	1886	31.3	2.63
25.....	66	53	60	0.09	Cloudy	19	1887	28.3	1.78
26.....	62	36	49	0.06	Cloudy	0	1888	27.0	1.88
27.....	59	31	45	0	Clear	100	1889	37.6	1.22
28.....	68	42	55	0.64	Partly Cloudy	82	1890	28.2	1.54
29.....	50	28	39	0.04	Cloudy	31	1891	29.3	2.41
30.....	58	28	43	0	Clear	95	1892	29.9	1.31
31.....	72	41	56	T.	Partly Cloudy	100	1893	28.2	2.82
							1894	40.1	1.25
							1895	27.2	0.27
							1896	28.7	1.31
							1897	33.0	2.08
							1898	37.0	3.59
							1899	26.3	3.30
Mean highest temperature.....						45.5	1900	23.6	1.88
Mean lowest temperature.....						24.9	1901	31.1	2.94
Mean temperature for month.....						35.2	1902	38.0	3.16
Total precipitation for month.....						3.57	1903	41.0	1.25
							1904	30.2	3.45
							1905	35.4	3.15
							1906	26.2	1.86
							1907	38.6	2.84
							1908	34.8	2.19
Number days clear.....						7	1909	29.9	0.90
Partly Cloudy.....						11	1910	44.0	0.40
Cloudy.....						13	1911	32.7	1.21
With 0.01 or more of precipitation.....						13	1912	22.4	1.92
							1913	31.0	3.76
							1914	31.1	1.52
							1915	30.1	0.78
							1916	26.2	3.09
							1917	34.6	2.88
Number hours sunshine.....						245.4	1918	37.1	3.58
Possible hours sunshine.....						370.5	1919	33.8	3.48
Percentage of possible.....						64	1920	35.2	3.57

WEATHER.

SUNSHINE.

BAROMETER—Mean, 29.91 inches; highest, 30.42 inches, on 18th; lowest, 29.12 inches, on 28th.
 TEMPERATURE—Highest, 72°, on 31st; lowest, 0°, on 6th; greatest daily range, 32°, on 22d; least daily range, 6°, on 19th.
 Normal for month, 32.3°; excess or deficiency this month, +3.0°. Accumulated excess or deficiency since January 1st, -257°;
 average daily, same period, -2.5°. Highest in 35 years, 82°; lowest, -12°.
 PRECIPITATION (in inches)—Total amount, 3.57; normal, 2.26; excess or deficiency this month, +1.31; since January 1st,
 -0.72. Greatest amount in any 24 hour period, 0.93, on 4th. Total snowfall, 3.7 inches.
 WIND—Prevailing direction, south; total movement, 7,258 miles; average hourly velocity, 9.8 miles. Maximum velocity 35,
 from the southeast, on 28th.
 DATES OF—Auroras, 22, 23; fog, dense, 0; hail, 28; thunderstorms, 15, 28; halos: solar, 3, 23, 24, 30; lunar, 0; frost: killing, —;
 heavy, —; light, —.

DEWEY A. SEELEY,
 METEOROLOGIST.

Monthly Meteorological Summary, Lansing, Michigan, April, 1920.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1.....	70	47	58	0.04	Cloudy.....	39	1863	.....	.....
2.....	58	30	44	0.02	Cloudy.....	38	1864	45.9	3.80
3.....	43	27	35	0	Partly Cloudy...	87	1865	47.4	2.32
4.....	34	23	28	0.81	Cloudy.....	0	1866	48.9	1.40
5.....	31	15	23	0.09	Cloudy.....	93	1867	48.2	2.19
6.....	35	13	24	0.01	Partly Cloudy...	88	1868	43.7	1.83
7.....	31	20	26	0.02	Cloudy.....	79	1869	45.7	3.42
8.....	32	19	26	0.01	Cloudy.....	54	1870	50.4	2.02
9.....	35	24	30	0	Cloudy.....	27	1871	49.8	2.97
10.....	46	24	35	0	Cloudy.....	76	1872	47.4	1.26
11.....	42	33	38	0.06	Cloudy.....	0	1873	43.2	3.88
12.....	37	24	30	0.17	Cloudy.....	29	1874	26.9	1.67
13.....	37	24	30	T.	Cloudy.....	11	1875	41.1	0.61
14.....	50	30	40	0	Clear.....	100	1876	44.2	2.08
15.....	48	33	40	0.43	Cloudy.....	10	1877	46.2	4.14
16.....	52	32	42	0	Cloudy.....	93	1878	50.6	3.76
17.....	57	33	45	0	Partly Cloudy...	83	1879	41.8	1.25
18.....	58	31	46	0	Cloudy.....	85	1880	45.9	7.06
19.....	55	32	44	0	Cloudy.....	76	1881	45.6	1.73
20.....	58	43	50	0.33	Cloudy.....	29	1882	41.7	1.88
21.....	66	48	57	0.26	Partly Cloudy...	69	1883	43.5	1.90
22.....	71	45	60	0.18	Cloudy.....	59	1884	43.7	1.95
23.....	53	37	45	0.22	Cloudy.....	28	1885	43.6	2.47
24.....	55	33	44	0	Clear.....	99	1886	50.2	1.99
25.....	53	33	43	0	Partly Cloudy...	100	1887	45.4	0.90
26.....	51	32	42	0.18	Cloudy.....	50	1888	41.0	1.15
27.....	46	37	42	0.07	Cloudy.....	4	1889	46.6	2.02
28.....	45	36	40	0.05	Cloudy.....	1	1890	47.2	3.20
29.....	60	31	47	0	Partly Cloudy...	100	1891	47.4	1.74
30.....	49	37	43	0.30	Cloudy.....	6	1892	41.5	2.04
31.....							1893	43.5	4.81
							1894	48.4	2.76
							1895	48.6	0.67
							1896	52.6	2.77
							1897	44.6	2.74
							1898	43.6	2.12
Mean highest temperature.....						48.7	1899	48.8	1.23
Mean lowest temperature.....						31.1	1900	47.4	2.00
Mean temperature for month.....						39.9	1901	46.4	2.16
Total precipitation for month.....						3.25	1902	44.6	1.70
							1903	43.0	4.40
							1904	39.4	0.50
							1905	44.6	1.49
							1906	46.6	2.43
							1907	37.8	2.81
							1908	44.6	2.15
Number days clear.....						2	1909	42.8	5.96
Partly cloudy.....						6	1910	49.2	2.48
Cloudy.....						22	1911	44.3	2.11
With 0.01 or more of precipitation.....						18	1912	45.6	3.12
							1913	45.9	3.10
							1914	44.7	2.90
							1915	51.6	1.06
							1916	45.7	1.91
							1917	42.4	5.59
Number hours sunshine.....						216.2	1918	42.4	1.97
Possible hours sunshine.....						402.5	1919	44.8	4.13
Percentage of possible.....						54	1920	39.9	3.25

BAROMETER—Mean, 29.81 inches; highest, 30.32 inches, on 25th; lowest, 29.22 inches, on 2nd.
TEMPERATURE—Highest, 74°, on 22nd; lowest, 13°, on 6th; greatest daily range, 29°, on 22nd; least daily range, 9°, on 27th.
Normal for month, 45.6°. Excess or deficiency this month, -5.7°. Accumulated excess or deficiency since January 1st, -429°; average daily, same period, -2.8°. Highest in 35 years, 88°; lowest, 10°.
PRECIPITATION (in inches)—Total amount, 3.25; normal, 2.54; excess or deficiency this month, +0.71; since January 1st, -0.01. Greatest amount in any 24 hour period, 0.90, on 5th and 6th. Total snowfall, 11.5 inches.
WIND—Prevailing direction, west; total movement, 5,093 miles; average hourly velocity, 8.5 miles; maximum velocity 30, from the west, on 2nd.
DATES OF—Auroras, 14, 17; hail, 22; thunderstorms, 20, 21, 22; halos: solar, 3, 5, 16, 17, 18, 20, 22, 25, 30; lunar, 1, 29, 30.
Frost: killing, 7, 8, 9, 10, 13, 14; heavy, 19, 24, 25; light, 26, 29.

DEWEY A. SEELEY,
METEOROLOGIST.

Monthly Meteorological Summary, Lansing, Michigan, May, 1920.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percent- age of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean tempera- ture.	Total precipita- tion.
1.....	58	30	44	0	Clear.....	100	1863		
2.....	50	30	40	0	Clear.....	100	1864	60 2	2 87
3.....	60	28	44	0	Partly Cloudy ..	98	1865	57 6	1 77
4.....	60	34	47	0	Partly Cloudy ..	99	1866	55 0	3 48
5.....	64	31	48	0	Clear.....	100	1867	61 1	3 80
6.....	69	36	52	0	Partly Cloudy ..	100	1868	59 1	2 80
7.....	69	41	55	0	Cloudy.....	100	1869	56 0	2 05
8.....	66	39	52	0	Partly Cloudy ..	94	1870	64 3	1 16
9.....	73	36	54	0 01	Partly Cloudy ..	72	1871	61 4	1 97
10.....	71	50	60	0 07	Cloudy.....	63	1872	58 5	3 72
11.....	57	41	49	0 32	Cloudy.....	37	1873	56 9	3 05
12.....	57	39	48	0	Cloudy.....	42	1874	59 6	1 77
13.....	51	34	42	0	Cloudy.....	63	1875	60 8	4 46
14.....	57	30	44	0	Partly Cloudy ..	96	1876	58 0	4 13
15.....	60	30	45	0	Clear.....	100	1877	58 2	2 23
16.....	66	35	50	0	Partly Cloudy ..	85	1878	54 6	3 44
17.....	56	47	52	0 78	Cloudy.....	0	1879	58 8	2 45
18.....	63	52	58	0 01	Cloudy.....	10	1880	64 3	5 59
19.....	73	50	62	0 20	Cloudy.....	47	1881	65 2	2 11
20.....	75	47	61	0 01	Partly Cloudy ..	68	1882	52 7	4 04
21.....	75	47	61	0	Clear.....	93	1883	52 8	5 66
22.....	80	50	65	0	Partly Cloudy ..	75	1884	56 9	3 95
23.....	77	60	68	0 03	Cloudy.....	40	1885	55 8	2 30
24.....	64	54	59	0	Cloudy.....	13	1886	58 1	2 67
25.....	76	56	66	0	Partly Cloudy ..	79	1887	64 3	2 42
26.....	82	49	66	0	Clear.....	100	1888	53 7	3 66
27.....	80	55	68	0	Partly Cloudy ..	95	1889	57 4	3 61
28.....	73	46	60	0	Partly Cloudy ..	100	1890	53 7	4 98
29.....	75	42	58	0	Clear.....	100	1891	55 7	1 63
30.....	80	45	62	0	Partly Cloudy ..	80	1892	54 5	5 92
31.....	81	54	68	0	Partly Cloudy ..	68	1893	54 4	2 86
							1894	56 9	4 83
							1895	61 8	2 06
							1896	66 5	3 14
							1897	55 8	3 29
							1898	56 5	2 15
							1899	58 8	3 59
							1900	58 8	4 17
							1901	55 2	2 42
							1902	58 4	4 92
							1903	59 5	2 63
							1904	57 4	2 40
							1905	56 7	5 17
							1906	56 6	3 05
							1907	51 2	2 22
							1908	59 6	5 59
							1909	55 8	2 44
							1910	51 5	4 13
							1911	63 5	2 67
							1912	57 6	6 57
							1913	56 2	2 22
							1914	58 6	4 66
							1915	51 5	2 74
							1916	56 6	5 13
							1917	50 2	3 37
							1918	61 1	2 89
							1919	54 5	4 29
							1920	55 1	1 13
Mean highest temperature..... 67 7									
Mean lowest temperature..... 42 5									
Mean temperature for month..... 55 1									
Total precipitation for month..... 1 43									
WEATHER.									
Number days clear..... 7									
Partly cloudy..... 14									
Cloudy..... 10									
With 0.01 or more of precipitation..... 8									
SUNSHINE.									
Number hours sunshine..... 339 2									
Possible hours sunshine..... 454 7									
Percentage of possible..... 75									

Monthly Meteorological Summary, Lansing, Michigan, June, 1920.

Date.	Temperature.			Precipitation in inches.	Character of day.	Percentage of possible sunshine.	This month since 1863.		
	Highest.	Lowest.	Mean.				Year.	Mean temperature.	Total precipitation.
1.....	80	62	71	0 22	Cloudy.....	46	1863	.....	.....
2.....	75	55	65	0 02	Cloudy.....	32	1864	67 6	3 88
3.....	70	48	59	0	Clear.....	100	1865	70 8	3 55
4.....	70	51	60	0	Partly Cloudy.....	79	1866	66 6	5 37
5.....	73	48	60	0	Clear.....	82	1867	71 6	2 83
6.....	76	45	60	0	Clear.....	95	1868	68 5	3 55
7.....	75	50	62	0	Cloudy.....	42	1869	64 4	4 40
8.....	83	58	70	0	Clear.....	100	1870	70 9	7 27
9.....	86	55	70	0	Partly Cloudy.....	88	1871	68 2	2 93
10.....	93	61	77	0	Partly Cloudy.....	99	1872	71 8	3 45
11.....	91	62	76	0 37	Partly Cloudy.....	86	1873	70 6	2 96
12.....	90	67	78	0	Clear.....	78	1874	70 6	5 07
13.....	87	68	78	0	Partly Cloudy.....	83	1875	66 6	1 84
14.....	85	67	76	0	Cloudy.....	51	1876	68 1	4 34
15.....	88	68	78	0 49	Partly Cloudy.....	54	1877	65 9	3 53
16.....	78	54	66	1 75	Cloudy.....	28	1878	64 1	3 15
17.....	67	49	58	0 28	Partly Cloudy.....	35	1879	66 0	2 87
18.....	73	47	60	T.	Partly Cloudy.....	90	1880	67 6	5 04
19.....	77	49	63	0	Clear.....	97	1881	64 3	4 37
20.....	72	50	61	0 69	Cloudy.....	17	1882	66 5	15 57
21.....	63	53	58	0 31	Cloudy.....	6	1883	65 9	1 35
22.....	72	52	62	0	Partly Cloudy.....	69	1884	68 9	2 83
23.....	74	51	62	0	Clear.....	78	1885	64 7	6 01
24.....	78	50	64	0	Clear.....	99	1886	65 7	1 92
25.....	82	54	68	0	Clear.....	96	1887	68 5	2 47
26.....	82	56	69	0	Clear.....	96	1888	67 9	2 51
27.....	84	56	70	0	Cloudy.....	55	1889	62 8	3 42
28.....	91	65	78	0	Clear.....	97	1890	70 3	3 92
29.....	83	68	76	0 04	Cloudy.....	52	1891	67 4	2 55
30.....	85	61	73	0	Partly Cloudy.....	80	1892	67 7	4 33
31.....	.....	.....	.....	.....	.....	.....	1893	66 6	4 85
							1894	71 4	1 30
							1895	71 4	1 01
							1896	69 9	2 60
							1897	64 2	2 57
							1898	67 6	4 91
Mean highest temperature.....						79 4	1899	68 2	1 15
Mean lowest temperature.....						56 0	1900	65 2	2 57
Mean temperature for month.....						67 7	1901	68 0	3 57
Total precipitation for month.....						4 17	1902	61 8	7 28
							1903	62 0	6 28
							1904	65 6	2 49
							1905	66 2	7 47
							1906	67 1	4 61
							1907	65 0	2 37
Number days clear.....						11	1908	70 0	1 23
Partly cloudy.....						10	1909	66 7	2 86
Cloudy.....						9	1910	64 9	1 95
With 0.01 or more of precipitation.....						9	1911	68 0	3 77
							1912	63 1	0 97
							1913	67 6	1 01
							1914	66 0	4 11
							1915	61 0	3 96
							1916	61 4	5 39
							1917	62 4	4 54
Number hours sunshine.....						323 2	1918	64 4	2 07
Possible hours sunshine.....						459 4	1919	71 9	3 18
Percentage of possible.....						70	1920	67 7	4 17

WEATHER.

Number days clear..... 11
 Partly cloudy..... 10
 Cloudy..... 9
 With 0.01 or more of precipitation..... 9

SUNSHINE.

Number hours sunshine..... 323 2
 Possible hours sunshine..... 459 4
 Percentage of possible..... 70

BAROMETER—Mean, 29.99 inches; highest, 30.34 inches, on 26th; lowest, 29.57 inches, on 16th.
 TEMPERATURE—Highest, 93°, on 10th; lowest, 45°, on 6th; greatest daily range, 32°, on 10th; least daily range, 10°, on 21st. Normal for month, 67.2°. Excess or deficiency this month, +0.5°. Accumulated excess or deficiency since January 1st, -47.7°; average daily, same period, -2.6°; highest in 35 years, 99°; lowest, 34°.
 PRECIPITATION (in inches)—Total amount, 4.17; normal, 3.40; excess or deficiency this month, +0.77; since January 1st, -1.39. Greatest amount in any 24 hour period, 2.19, on 15th and 16th. Total snowfall, 0.0 inches.
 WIND—Prevailing direction, south; total movement, 3,205 miles; average hourly velocity, 4.5 miles. Maximum velocity 24, from the northwest, on 11th.
 DATES OF—Auroras, 0; hail, 0; thunderstorms, 1, 11, 12, 15, 16. Halos: solar, 20, 28; lunar, 27, 28, 29. Frost: killing, 0; heavy, 0; light, 0.

DEWEY A. SEELEY,
 METEOROLOGIST.

REPORT OF DIVISION OF EXTENSION WORK.

President F. S. Kedzie,

Dear Sir:—The activities of the Extension division for the fiscal year are fully covered in the project reports appended hereto. In transmitting these statements to you, I wish to call attention to the new forces which greatly affect all agricultural activities of a public service character. I refer to the growth of the rural organization movement now taking on definite forms and functions in the state and county farm bureaus, and the purely marketing associations and exchanges. I wish to assure you that the full force of all the lines of service of the College have been made to apply where wanted and needed on these problems and no effort has been spared to assist by counsel and actual organization effort to direct these movements toward safe, efficient policies.

It is difficult in reporting upon any public service work to find any adequate measure of its value to the State. You will find in the following reports records of how the time has been spent, how many meetings have been held, how many people have been reached, etc., and yet this expresses very poorly the character and value of the work done. Effort has been made to record the actual money value of the service, but such data appear always to be questionable estimates, appearing too high or too low according to the viewpoint of the individual. I am convinced that no money value can be placed on public service work and any attempt to do so may be unfair because of smallness of vision of the whole industry affected or because of the exaggeration of an unimportant detail.

The measure of results which is most satisfactory to the worker and the public also is the expression of appreciation coming from the people benefited by the service. However, such appreciation cannot be put in concrete form in an official report, but I want to assure you that expressions of this kind have been very generous during the year and have given the workers greater courage, optimism and faith in their work for the coming year.

The work of the Extension division under the terms of the Smith-Lever law is cooperative with the United States Department of Agriculture; the cooperation being carried into effect through the Office of Extension Work, North and West, of the States Relations Service. Our relationship with this office during the year has been most pleasant and helpful. Through its Chief we have been able to make advantageous contact with the various bureaus of the Department of Agriculture making their services available in Michigan.

PUBLICATIONS.

Edition.	Bulletin.	Title.	Pages.	Author.
20,000	No. 10	Canning Clubs	28	Anna Bryant Cowles.
30,000	No. 27	Extension Jellies Course Notes	4	Home Econ. Extension Dept.
10,000	No. 1	Inoculation of Legumes	4	Dr. Ward Giltner.
20,000	No. 12	Suggestions to Boys who wish to prepare for Farm Work.....	16	Ashley M. Berridge.
3,000	No. 26	Course Notes (Layettes)	2	Home Econ. Dept.
3,000	No. 19	Ext. Course Notes, Preservation of Meats	4	Home Econ. Dept.
3,000	No. 21	Extension Course Notes. The Care of Clothing	4	Home Econ. Dept.
3,000	No. 22	Extension Course Notes. How to know Materials	4	Home Econ. Dept.
3,000	No. 23	Extension Course Notes. How to Buy Clothing	4	Home Econ. Dept.
3,000	No. 24	Extension Course Notes. Home Dressmaking Patterns	4	Home Econ. Dept.
20,000	No. 12	(Revised) Hot Lunch Project	43	Miss B. VanHeulen and Miss M. Hutty.
30,000	No. 17	The Stinking Smut of Wheat	4	Dr. G. H. Coons.
30,000	No. 21	Poultry Culling	17	E. C. Foreman.

Appointments:

Wm. Murphy, Specialist Farm Crops, Retd. From Military Service, Aug. 1, 1919.

Roy E. Decker, County Agent, Eaton, Aug. 20, 1919.

Russell M. Hain, Specialist Insect Pests, Sept. 1, 1919.

Marion Rogers, Home Demonstration Agent, Wayne, Sept. 1, 1919.

E. O. Anderson, County Agent, Macomb, Sept. 23, 1919.

C. P. Pressley, County Agent, Schoolcraft, Nov. 5, 1919.

O. F. Marvin, County Agent, Muskegon, Nov. & Dec. temporarily.

Ann R. Banks, County Club Leader, Cheboygan, Jan. 16, 1920.

L. L. Drake, County Agent, Antrim, Jan. 16, 1920.

H. V. Kittle, County Agent, Clinton, Feb. 1, 1920.

M. F. Jackson, County Agent, Mecosta, Feb. 1, 1920.

S. J. Linck, County Agent, Muskegon, Feb. 1, 1920.

A. J. Hutchins, County Agent, St. Joseph, Feb. 1, 1920.

Eva Carrett, Home Demonstration Agent, Oakland, Feb. 1, 1920.

Donald Williams, Specialist Live Stock, Mar. 1, 1920.

A. G. Bovay, County Agent, Saginaw, Mar. 1, 1920.

K. H. Miller, County Agent, Dickinson, Mar. 20, 1920.

Kris P. Bemis, County Agent, Mason, Mar. 22, 1920.

H. C. Rafter, County Agent, Farm Crops, Apr. 1, 1920.

D. F. Rainey, Specialist Farm Crops, Apr. 1, 1920.

L. V. Benjamin, County Agent, Baraga, Apr. 1, 1920.

C. P. Johnson, County Agent, Alger, Apr. 1, 1920.

M. C. Thomas, County Agent, Monroe, Apr. 15, 1920.

Geo. E. Smith, County Agent, Oceana, Apr. 15, 1920.

Lawrence Bauman, County Club Leader, Saginaw, Apr. 16, 1920.

Frank W. Bennett, County Agent, Barry, Apr. 20, 1920.

Grace Pinnell, Home Demonstration Agent, Manistee, Apr. 20, 1920.

Edw. S. Brewer, County Agent, Presque Isle, Apr. 26, 1920.

John D. Martin, County Agent, Sanilac, June 1, 1920.

F. L. Simanton, County Agent, Berrien, June 16, 1920.

Howard Eliot, Farm Management Demonstrator, June 24, 1920.

Transfers:

- Barbara Van Heulen, Promoted Ass't State Club Leader, Sept. 1, 1920.
 W. C. Cribbs, Antrim County Agent to Markets Specialists, Sept. 30, 1919.
 R. L. Olds, County Agent Muskegon to Kalamazoo, Nov. 1, 1919.
 Irving Kirshman, County Agent Baraga to Menominee, Dec. 1, 1919.
 W. F. Johnston, County Agent Roscommon & Crawford to Wexford, Jan. 1, 1920.
 Eva Carrett, Home Demonstration Agent, Cass to Oakland, Feb. 1, 1920.
 C. V. Ballard, County Agent, Dickinson to Jackson, Mar. 21, 1920.
 Wm. Murphy, From Farm Crops Specialist to Macomb County Agent, Mar. 22, 1920.
 Ralph Carr, County Agent Monroe, to Lenawee, Apr. 1, 1920.
 C. P. Milham, County Agent Iosco, to Ottawa, Apr. 1, 1920.
 C. M. Kidman, County Agent Presque Isle, to Cass, May 1, 1920.

Resignations:

- John H. Carmody, Specialist Horticulture, July 31, 1919.
 H. V. Kittle, County Agent, Macomb, Aug. 31, 1919.
 B. F. Beach, County Agent, Oceana, Aug. 31, 1919.
 Anna B. Cowles, Boys' & Girls' Club Ass't Leader, Aug. 31, 1919.
 W. J. Cook, County Agent, Mason, Sept. 1, 1919.
 E. G. Amos, County Agent, Menominee, Sept. 1, 1919.
 Laverne Jones, Home Demonstration Agent, St. Joseph, Sept. 1, 1919.
 P. P. Pope, County Agent, Clinton, Sept. 30, 1919.
 May M. Person, State Leader Home Demonstration Agents, Sept. 30, 1919.
 Bessie Turner, Home Demonstration Agent, Berrien, Sept. 30, 1919.
 Jason Woodman, County Agent, Kalamazoo, Oct. 1, 1919.
 Simon Harkema, County Agent, Nawaygo, Nov. 1, 1919.
 Clark Mason, County Agent, Wexford, Nov. 15, 1919.
 Eva Carrett, Home Demonstration Agent, Cass, Nov. 15, 1919.
 Jesse Stutsman, County Agent, Saginaw, Nov. 30, 1919.
 Ruth E. Wheaton, County Club Leader, Cheboygan, Nov. 30, 1919.
 F. A. Davis, County Club Leader, Kent, Nov. 30, 1919.
 A. L. Olsen, County Agent, Alger, Dec. 15, 1919.
 Theresa, McDonald, County Club Leader, Saginaw, Dec. 15, 1919.
 E. K. Chamberlain, Specialist Farm Crops, Dec. 31, 1919.
 Glen S. Kies, County Club Leader, Ingham, Dec. 31, 1919.
 E. P. Robinson, Asst. State Leader County Agents, Dec. 30, 1919.
 Paul H. Smith, County Agent, Mecosta, Dec. 31, 1919.
 J. M. Wendt, County Agent, St. Joseph, Dec. 31, 1919.
 E. C. Mandenberg, Specialist Forestry, Jan. 1, 1920.
 J. V. Sheap, County Agent, Jackson, Jan. 1, 1920.
 Howard Hinds, County Agent, Montmorency, Jan. 31, 1920.
 D. L. Hagerman, County Agent, Ottawa, Feb. 21, 1920.
 C. L. Rose, County Agent, Osceola, Feb. 29, 1920.
 E. O. Anderson, County Agent, Macomb, Mar. 9, 1920.
 Frank Sandhammer, Asst. County Agent Leader, Mar. 15, 1920.

R. V. Tanner, County Agent, Barry, Mar. 31, 1920.

Chas. H. Graves, Farm Management Demonstrator, Apr. 1, 1920.

C. L. Coffeen, County Agent, Lenawee, Apr. 1, 1920.

Alice Kuenzli, Home Demonstration Agent, Manistee, Apr. 10, 1920.

David Woodman, County Agent, Cass, May 1, 1920.

H. J. Lurkins, County Agent, Berrien, May 31, 1920.

Jennie Williams, Home Demonstration Agent, Schoolcraft, June 30, 1920.

Geo. C. Raviler, Agent in Organization Markets, June 30, 1920.

Annabel Campbell, Specialist Poultry, June 30, 1920.

R. J. BALDWIN,
Director.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION SCHOOLS AND FARMERS' MEETINGS.

BY KARL H. MC DONEL.

Extension schools and farmers' meetings were held during the winter months beginning November first and lasting until the first of April.

The plan of the work was somewhat different than that of the past, for as the counties become better organized, it is necessary to make changes so that our work will fit their program.

Meetings were only held where there was a definite demand or request for help. Then we assigned a specialist for one or two days, who would discuss the question thoroughly, and if possible, start a program of work that could be followed up during the succeeding months. In this way the specialist was doing definite constructive work, and at the same time developing a program of work for the following year. By this system, only subjects that are of relative importance to the community were discussed, and the people were interested and ready to take hold and do some real work that will result in bettering the community and at the same time associate them very closely with the College.

In many cases the specialist was able to get an actual demonstration started for the coming season. This enabled the specialists to get their work well outlined and started early in the year.

Most of the meetings were for one day only, a few for two, and a very few for three days. The arrangements were all made through the county agent and home demonstration agent.

The following subjects were discussed: Farm Crops, Farm Management, Animal Husbandry, Muck Crops, Soils, Insect Pests, Farm Engineering, Poultry, Home Economics, Horticulture, Dairy Husbandry, Drainage, and Marketing.

It was not necessary to hire additional assistance, as in previous years, as by holding a session for only one day, one man could take care of many more meetings than under the two day session. Whenever it was possible for members of the faculty to get away they assisted.

The latter part of the winter, we were handicapped somewhat by

the influenza epidemic, especially among members of the staff, and it was necessary in many cases to cancel well prepared meetings.

We furnished one specialist all the time and another part time to assist with the International Harvester Company, G. R. & I. Railroad, Pere Marquette Railroad, Northwestern Development Bureau, and University of Michigan. These meetings were all held on the west side of the State, and covered a period of about two weeks. The following tables summarize the different meetings:

AGRICULTURAL MEETINGS.

Name of place.	County.	Subject.	Total at- tendance.
Sheldon.....	Wayne.....	Soils.....	25
Romulus.....	Wayne.....	Soils.....	45
W. Sumpter.....	Wayne.....	Soils.....	111
Merle Beach.....	Clinton.....	Farm Crops.....	48
Garfield.....	Newaygo.....	Potatoes and Vegetables.....	50
Eagle.....	Clinton.....	Farm Crops.....	60
Saginaw.....	Saginaw.....	Dairy.....	70
Edwardsburg.....	Cass.....	Soils.....	38
Daley.....	Cass.....	Soils.....	115
Fennville.....	Allegan.....	Soils.....	110
Martin.....	Allegan.....	Soils.....	65
Wayland.....	Allegan.....	Soils.....	145
East Nankin.....	Wayne.....	Potatoes and Vegetables.....	40
Beech.....	Wayne.....	Potatoes and Vegetables.....	110
Plymouth.....	Wayne.....	Potatoes and Vegetables.....	45
Brighton.....	Livingston.....	Potatoes and Vegetables.....	40
Benton Harbor.....	Berrien.....	Horticulture.....	150
Albion.....	Calhoun.....	Farm Crops.....	175
Ceresco.....	Calhoun.....	Farm Crops.....	30
West Branch.....	Ogemaw.....	Potatoes and Vegetables.....	35
Wayland.....	Allegan.....	Insect Pests.....	50
Kibbie.....	Allegan.....	Insect Pests.....	25
Port Huron.....	St. Clair.....	Poultry.....	10
Howard City.....	Montcalm.....	Live Stock.....	30
Woodland.....	Barry.....	Dairy.....	102
Middleville.....	Barry.....	Dairy.....	119
Hastings.....	Barry.....	Dairy.....	66
Caro.....	Tuscola.....	Dairy.....	50
Eagle.....	Clinton.....	Dairy.....	110
Bard.....	Gladwin.....	Drainage.....	53
Dale.....	Gladwin.....	Drainage.....	63
Billings.....	Gladwin.....	Drainage.....	25
Hillards.....	Allegan.....	Potatoes and Vegetables.....	75
Plainwell.....	Allegan.....	Potatoes and Vegetables.....	15
East Leroy.....	Calhoun.....	Horticulture.....	75
Battle Creek.....	Calhoun.....	Horticulture.....	00
Albion.....	Calhoun.....	Horticulture.....	20
Algaussee.....	Branch.....	Farm Crops.....	30
Geddo.....	St. Clair.....	Farm Crops.....	68
Caesopolis.....	Cass.....	Farm Crops.....	82
Calvin.....	Cass.....	Farm Crops.....	52
Homer.....	Calhoun.....	Soils.....	75
Marshall.....	Calhoun.....	Soils.....	45
Bay City.....	Bay.....	Apiculture.....	50
Grand Rapids.....	Kent.....	Apiculture.....	60
Ann Arbor.....	Washtenaw.....	Apiculture.....	23
Marshall.....	Calhoun.....	Apiculture.....	22
Ionia.....	Ionia.....	Apiculture.....	20
Allegan.....	Allegan.....	Apiculture.....	27
Richmond.....	Macomb.....	Poultry.....	31
Nashville.....	Barry.....	Dairy.....	165
Gaines.....	Genesee.....	Dairy.....	65
Marcellus.....	Cass.....	Dairy.....	85
Allegan.....	Allegan.....	Dairy.....	215
Burnips.....	Allegan.....	Dairy.....	105
Hopkins.....	Allegan.....	Dairy.....	65
Azalia.....	Monroe.....	Dairy.....	97
Millburg.....	Berrien.....	Horticulture.....	50
Fennville.....	Allegan.....	Horticulture.....	12
Whitmore.....	Iosco.....	Soils.....	18
Sherman.....	Iosco.....	Soils.....	27
Tawas City.....	Iosco.....	Soils.....	8
Vicksburg.....	Kalamazoo.....	Soils.....	67
Mt. Pleasant.....	Isabella.....	Apiculture.....	40
Kaleva.....	Manistee.....	Potatoes and Vegetables, Dairy, Poultry.....	310
Milan.....	Washtenaw.....	Farm Management, Poultry.....	250
Starville.....	St. Clair.....	Drainage.....	60
China.....	St. Clair.....	Drainage.....	45
New Boston.....	Wayne.....	Drainage.....	60
Sumpter.....	Wayne.....	Drainage.....	50
St. Joseph.....	Berrien.....	Horticulture.....	75
Ravenna.....	Muskegon.....	Farm Crops.....	110
Matteson.....	Branch.....	Soils.....	53
Ypsilanti.....	Washtenaw.....	Soils.....	177

EXTENSION DIVISION.

161

AGRICULTURAL MEETINGS.—Concluded.

Name of place.	County.	Subject.	Total attendance.
Hillsdale	Hillsdale	Live Stock	50
Kaleva	Manistee	Dairy, poultry	1,150
Sparta	Kent	Dairy	275
Millburg	Berrien	Horticulture	101
Fennville	Allegan	Horticulture	15
Centerville	St. Joseph	Live Stock	37
Charlotte	Elston	Live Stock	52
Prescott	Ogemaw	Dairy	24
Ada	Kent	Horticulture	60
Gilead	Branch	Farm Crops	150
Ellsworth	Antrim	Farm Crops	26
Central Lake	Antrim	Farm Crops	25
Rose City	Ogemaw	Farm Crops	45
Prescott	Ogemaw	Farm Crops	50
Sherman	Iosco	Farm Crops	23
South Haven	Berrien	Insect Pests	200
Hastings	Barry	Apiculture	22
Pontiac	Oakland	Apiculture	20
Alma	Gratiot	Apiculture	16
St. Johns	Clinton	Apiculture	20
Port Huron	St. Clair	Apiculture	23
Petoskey	Emmet	Dairy	42
Hart	Oceana	Dairy	68
Fremont	Newaygo	Live Stock	25
Bendon	Benzie	Potatoes and Vegetables	10
Boulah	Benzie	Potatoes and Vegetables	60
Coldwater	Branch	Poultry	252
West Branch	Ogemaw	Farm Crops	40
West Branch	Ogemaw	Dairy	24
Marlette	Saukabe	Farm Crops	16
Hillsdale	Hillsdale	Farm Crops	32
Durand	Shiawassee	Live Stock	37
Lathrop	Shiawassee	Live Stock	33
Watervliet	Berrien	Live Stock	85
Hillsdale	Hillsdale	Apiculture	11
Muskegon	Muskegon	Apiculture	12
Mesick	Wexford	Farm Crops	260
Buckley	Wexford	Farm Crops	50
Lakeview	Montcalm	Farm Crops	60
Petoskey	Emmet	Potatoes and Vegetables	60
Levering	Cheboygan	Potatoes and Vegetables	89
Branch Township	Emmet	Potatoes and Vegetables	25
Alba	Antrim	Potatoes and Vegetables	55
Mancelona	Antrim	Potatoes and Vegetables	12
Crystal Falls	Iron	Dairy	10
Ama a	Iron	Dairy	85
Baumgartner	Iron	Dairy	70
Republic	Marquette	Dairy	25
Green Garden	Marquette	Dairy	30
Skandia	Marquette	Dairy	27
Bark River	Delta	Dairy	82
Isabella	Delta	Dairy	66
Fayette	Delta	Dairy	29
Cooks	Schoolcraft	Dairy	47
Upper Hiawatha	Schoolcraft	Dairy	43
Marblehead	Schoolcraft	Dairy	27
Faithorn	Mecuminee	Dairy	68
Daggett	Mecuminee	Dairy	48
Lakeview	Montcalm	Dairy	56
Evert	Oscola	Dairy	5
Bentley	Bay	Dairy	11
Pokagon	Cass	Soils	150
Vandalia	Cass	Soils	115
Total			10,697

HOME ECONOMICS MEETINGS.

Name of place.	County.	Subject.	Total attendance.
Romeo.....	Macomb.....	Foods.....	100
Hartford.....	Van Buren.....	Foods.....	40
Lansing.....	Ingham.....	Foods.....	50
Alamo.....	Kalamazoo.....	Foods.....	25
Vicksburg.....	Kalamazoo.....	Foods.....	20
Smith's School House.....	Kalamazoo.....	Foods.....	20
Portage.....	Kalamazoo.....	Foods.....	35
Otsego.....	Kalamazoo.....	Foods.....	75
Three Rivers.....	St. Joseph.....	Foods.....	35
Manton.....	Wexford.....	Foods.....	14
Manton.....	Wexford.....	Foods.....	48
Vicksburg.....	Kalamazoo.....	Foods.....	25
Kalamazoo.....	Kalamazoo.....	Foods.....	75
Damon Church.....	Kalamazoo.....	Foods.....	25
Coldwater.....	Branch.....	Clothing.....	125
Cherry Hill.....	Wayne.....	Clothing.....	7
Belleville.....	Wayne.....	Clothing.....	8
Belleville.....	Wayne.....	Clothing.....	15
Manistique.....	Schoolcraft.....	Clothing.....	12
Wakefield.....	Gegebic.....	Clothing.....	15
Iron Mountain.....	Dickinson.....	Clothing.....	15
Quinnesec.....	Dickinson.....	Clothing.....	15
Quincy.....	Houghton.....	Clothing.....	9
P. rt Huron.....	St. Clair.....	Clothing.....	17
Port Huron.....	St. Clair.....	Clothing.....	17
Allenton.....	St. Clair.....	Clothing.....	19
Allenton.....	St. Clair.....	Clothing.....	19
Ypsilanti.....	Washtenaw.....	Clothing.....	66
Ypsilanti.....	Washtenaw.....	Clothing.....	75
Dearborn.....	Wayne.....	Clothing.....	15
Dearborn.....	Wayne.....	Clothing.....	34
Cherry Hill.....	Wayne.....	Clothing.....	15
Memphis.....	St. Clair.....	Clothing.....	20
Memphis.....	St. Clair.....	Clothing.....	23
Memphis.....	St. Clair.....	Clothing.....	24
Memphis.....	St. Clair.....	Clothing.....	30
Ovid.....	Clinton.....	Clothing.....	10
Jasper.....	Lenawee.....	Clothing.....	20
Allegan.....	Allegan.....	Clothing.....	200
Allegan.....	Allegan.....	Clothing.....	15
Gun Plains.....	Allegan.....	Clothing.....	10
Gun Plains.....	Allegan.....	Clothing.....	20
Hamilton.....	Allegan.....	Clothing.....	16
Coldwater.....	Branch.....	Clothing.....	32
Coldwater.....	Branch.....	Clothing.....	41
Coldwater.....	Branch.....	Clothing.....	75
Marquette.....	Schoolcraft.....	Clothing.....	15
Manistique.....	Schoolcraft.....	Clothing.....	50
Houghton.....	Houghton.....	Clothing.....	50
Trap Rock.....	Houghton.....	Clothing.....	16
Chassell.....	Houghton.....	Clothing.....	50
Cooks.....	Schoolcraft.....	Clothing.....	40
Hiawatha.....	Schoolcraft.....	Clothing.....	40
Marblehead.....	Schoolcraft.....	Clothing.....	35
Marquette.....	Marquette.....	Clothing.....	25
Tapiola.....	Marquette.....	Clothing.....	200
Marquette.....	Marquette.....	Clothing.....	6
Marquette.....	Marquette.....	Clothing.....	100
Witbeck.....	Marquette.....	Clothing.....	18
Witch Lake.....	Marquette.....	Clothing.....	28
Marquette.....	Marquette.....	Clothing.....	5
Marquette.....	Marquette.....	Clothing.....	11
Marquette.....	Marquette.....	Clothing.....	11
Richland.....	Kalamazoo.....	Household Management.....	28
Texas.....	Kalamazoo.....	Household Management.....	48
Culton.....	Kalamazoo.....	Household Management.....	54
Trafford School.....	Kalamazoo.....	Household Management.....	38
Eagle.....	Clinton.....	Household Management.....	48
Vicksburg.....	Kalamazoo.....	Household Management.....	16
Hopkins.....	Allegan.....	Household Management.....	24
East Nankin.....	Wayne.....	Household Management.....	30
Beech.....	Wayne.....	Household Management.....	40
Plymouth.....	Wayne.....	Household Management.....	35

HOME ECONOMICS MEETINGS.—Concluded.

Name of place.	County.	Subject.	Total attendance.
Fennville.....	Allegan.....	Household Management.....	50
Martin.....	Allegan.....	Household Management.....	45
Wayland.....	Allegan.....	Household Management.....	36
Kaleva.....	Manistee.....	Household Management.....	900
Osego.....	Allegan.....	Household Management.....	61
Middleville.....	Barry.....	Household Management.....	96
Orangeville.....	Barry.....	Household Management.....	32
Cressy.....	Barry.....	Household Management.....	125
Menominee.....	Menominee.....	Household Management.....	26
Menominee.....	Menominee.....	Household Management.....	125
Wakefield.....	Gogebic.....	Household Management.....	21
Mesick.....	Wexford.....	Household Management.....	39
Buckley.....	Wexford.....	Household Management.....	45
Total.....			4,330

INTERNATIONAL HARVESTER COMPANY, M. A. C., U. of M., WESTERN MICHIGAN DEVELOPMENT BUREAU
G. R. & I. RY., AND P. M. RY., MEETINGS.

Name of place.	County.	Total attendance.
Sparta.....	Kent.....	80
Conklin.....	Ottawa.....	325
Hudsonville.....	Ottawa.....	500
Holland.....	Ottawa.....	460
Fremont.....	Newaygo.....	510
Ewart.....	Osceola.....	100
Bellaire.....	Antrim.....	325
Harbor Springs.....	Emmet.....	475
Traverse City.....	Grand Traverse.....	256
Total.....		3,031

GRAND TOTAL OF MEETINGS.

	Total attendance.
Agricultural.....	10,007
Home Economics.....	4,330
International Harvester.....	3,031
Western Michigan Development Bureau, etc.....	
Total.....	17,368

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK IN FARM CROPS.

Mr. R. J. Baldwin, M. A. C.

Dear Mr. Baldwin:—I herewith present report of the Extension Work in Farm Crops for the past year.

As you are aware the work in crops extension has been greatly influenced by new developments in the agricultural field, such as the formation of the county and state organization of the Farm Bureau, and the great movement from country to city of farmers and farm help, amounting to approximately 9% in one year.

On the other hand, the extension work in crops has had considerable influence on the development of the departments of the Farm Bureau, notably the department for the safe handling of seeds.

Mr. J. W. Nicolson, Extension Specialist in Crops and Secretary of the Crop Improvement Association was placed in charge of the seed department of the Farm Bureau and resigned as Extension Specialist March 1st. In his new capacity he continues as one of the directors of the Crop Improvement Association. The cooperation of the Crop Improvement Association and the seed department of the Farm Bureau will greatly aid in the wide spread distribution of sound seed of improved crops varieties.

Such work as the purchase from the Northwest, under inspection, of Grimm and other northern grown varieties of alfalfa seed begun by Mr. Nicolson, while Extension Specialist and Secretary of the Michigan Crop Improvement Association, will be continued by the seed department of the Farm Bureau on a much more extensive scale. The seed department of the Farm Bureau will also cooperate with the Crop Improvement Association in the distribution of registered and certified seed of Rosen rye, Red Rock wheat, Wolverine, Worthy, and College Success oats, improved varieties of barley and corn, Robust beans, etc.

As Extension Specialist, Mr. Nicolson rendered great service to the State of Michigan in forwarding the use of improved varieties and encouraging better methods of crop production. His co-workers take pride in the fact that he has been selected for the important work of accomplishing the development of the newly established Farm Bureau seed department.

Briefly stated, the main lines of Farm Crops Extension are as follows:

1.—Improvement in the yield and quality of crops through the wide spread introduction of improved crops varieties.

2.—Cooperation with the county agricultural agents and farm bureaus in the development of crops projects, fair exhibits, etc.

3.—Cooperative demonstrations of best production methods, variety adaptations, etc.

4.—General extension correspondence, news letters, addresses, etc.

The first of these projects is made particularly effective through the cooperation of the Michigan Crop Improvement Association, an organization of Michigan farmers who are interested in the growing of the highest yielding varieties, using best methods of cultivation and fertilization.

On April 1st, Professor A. L. Bibbins was appointed Extension Specialist in Farm Crops (three-fourths time) and elected by the Directors of the Association to serve as secretary.

At the present time, the members of the Michigan Crop Improvement Association number approximately 600 farmers who are actively engaged in the production of high yielding seed from selected strains, developed by the plant breeder of the Michigan Agricultural College. Briefly the machinery of distribution is as follows:

Varieties developed by the plant breeding work of the Crops section which have proven their outstanding worth in comparative tests, are increased on the Farm Crops section increase plats and distributed to members of Crop Improvement Association for further increase.

The Secretary of the Association maintains a careful registry of all strains distributed and the association supports a careful inspection of grain in the field and after threshing. Fields, which pass the certification requirements of the Association are certified and sold at a price agreed upon by the growers, under guarantee. The inspection of grains in the field is carried on under the direction of the Farm Crops department.

The work of the Association continues to be particularly effective for the distribution of Rosen rye, Red Rock wheat, Michigan 2-Row and Black Barbless barley, Wolverine and College Wonder oats, Robust beans and improved varieties of corn. Under the new arrangement, existing with the Farm Bureau seed department, the distribution of these varieties is facilitated by that organization. While the Crop Improvement Association continues to publish a seed list, the commercial sale of seed will be very largely directed through this new channel.

Mr. A. L. Bibbins, Secretary of the Crop Improvement Association, reports the following cooperative demonstrations with pure seed of high yielding varieties with members of the association:

Pedigreed Oats	44
Pedigreed Spring Barley.....	37
Pedigreed Winter Barley.....	6
Pedigreed Wheat	32
Pedigreed Corn	74
Pedigreed Robust Beans.....	17
Pedigreed Early Wonder	32
Pedigreed Soy Beans	21

2.—*County Agents and Farm Bureau Cooperation in Crops Work.* This project was largely under the direction of Mr. William Murphy until the date of his resignation, April 1st, to serve as County Agent in Macomb county. On May 1st, Mr. H. C. Rather was appointed to take charge of this project.

The organization of numerous county farm bureaus and the consequent effect on the work of the county agricultural agents, has made it necessary to follow closely the new developments in county organizations, and to devise methods of insuring the most useful cooperation in methods related to crop production. Increased demands for service are now being placed upon extension specialists in crops as a result of the more complete organization of farmers throughout the State.

Additional interest has lately been taken in crops exhibits at state and county farmers' organization fair exhibits. During the present season arrangements have been made to hold exhibits at state and county farmer's organization fairs and three leading State Fairs—Detroit, Grand Rapids, and Bay City—and with a number of county agents and farm bureaus. During the past year the following exhibits were held:

Estimated Attendance at Exhibit.

Michigan State Fair, Detroit, 60 ft. Wall & Table Space.....	75,000
Jackson County Fair, Jackson, 30 ft. Wall & Table Space.....	15,000
West Michigan State Fair, Grand Rapids, 50 ft. Space.....	70,000
North Eastern State Fair, Bay City, 35 ft. Space.....	20,000
Chicago International, Chicago, 70 ft. (Special appropriation by Board of Agriculture, M. A. C).....	100,000
Michigan Crop Imp. Ass'n Exhibit (Farmer's Week) 300 ft....	6,000
In addition to these, demonstrations were conducted at twelve small fairs with total of 135 ft. space and total attendance of 100,000	

3.—*Cooperative demonstrations of variety adaptation and cultural methods.* The organization of county farm bureaus on a firm basis has apparently greatly stimulated the need for information regarding the leading crop varieties, since the formation of cooperative farmers' organization has led to a clear understanding of the need of standardized production. In order to provide this information and to furnish also a safe basis for the introduction of new varieties, it has been necessary to establish a department of cooperative tests.

One-third of the time of the man in charge of cooperative tests is carried on Experiment Station payroll and two-thirds on Extension. The cost of seed, special apparatus, and the planting of plats, etc., is carried on Experiment Station funds. The Extension funds pay for two-thirds time of the man in charge, and traveling expenses. During the period of the year when not engaged in planting tests, the specialist gives his time to demonstration work. Mr. D. F. Rainey who is at present in charge of this work, reports the following tests now in process:

Emmet—Barley, Soy Beans.
 Kalkaska—Barley, Soy Beans.
 Montcalm—Barley, Oats, Soy Beans, Corn.
 Macomb—Barley, Oats and Corn.
 Wayne—Barley, Oats, Soy Beans, Corn.
 Calhoun—Barley, Oats, Soy Beans, Field Beans, Corn.
 Van Buren—Barley, Oats, Soy Beans, Corn, Alfalfa, Wheat.
 Lapeer—Oats.
 Benzie—Soy Beans, Corn.
 Manistee—Soy Beans.
 Eaton—Soy Beans.
 Tuscola—Soy Beans, 3 Corn, 1 Wheat.
 Monroe—Wheat.
 Ingham—Soy Beans, Field Beans, Corn.
 Branch—Wheat.
 Huron—Field Beans.

Ottawa—Corn, Alfalfa.
 Washtenaw—Corn.
 Hillsdale—Corn.
 St. Clair—2 Wheat.

4.—*General Extension—correspondence, news letters, addresses, etc:—*

At irregular intervals the department has issued twelve farm crops news letters on timely subjects which are mailed to the county agents and about nine hundred farmers throughout the State. In addition to this, there have been published 30,000 Extension circulars on Michigan Rosen rye, also one hundred and ten articles to 450 rural papers of the State. We are informed that this publicity service is highly valued.

Members of the department are called upon to carry an extensive correspondence in answering the inquiries of county agents and farmers concerning their crop products problems.

Summary of Correspondence— July 1, 1919—July 1, 1920.

Number of first class letters	7094
Number of second class letters	16427

The effectiveness of extension work in farm crops has been greatly stabilized through closer association with experimental and college work. This is accomplished through placing the offices and working laboratories of extension workers in close contact with those of station and college workers, thus giving the men in various lines of work frequent opportunity for close association and interchange of ideas. The placing of one extension man on college work for part time and another specialist on experiment station roll for part time has further cemented the relationship between these departments. At times when general calls from the field have placed a heavy load on extension workers, this close association with the college and station staff aids greatly in meeting emergencies.

I wish to express my great appreciation and the appreciation of the Farm Crops Staff engaged in extension work for the hearty cooperation of our co-workers in other departments, and of county agricultural agents throughout the State, whose efforts have made possible the accomplishment of the majority of our projects.

The extension activities, during the past year, have been called upon to meet new situations with increased responsibility. Every effort has been made to place the extension work on a basis to meet with the intensified demand for service which is anticipated during the coming years.

Cordially yours,

J. F. COX,

Professor of Farm Crops.

East Lansing, Mich., June 30, 1920.

Director R. J. Baldwin,
Extension Division,

Dear Director Baldwin:—The following is a brief report of the work in farm crops extension performed by the writer between July 1, 1919 and March 1, 1920.

Farms visited	160
Demonstrations held	4
Attendance at Demonstrations	235
Lecture meetings	52
Attendance at Lectures	2626
Mail sent out from July 1, 1919 to March 1, 1920.	
1st class	7065
2d class	2089
News Letters	4435

The results of the cooperative work can be compiled by my successor from the records.

Very truly yours,
J. W. NICOLSON,
Manager Seed Department.

ANNUAL REPORT OF THE EXTENSION SPECIALIST IN DAIRYING.

The work of the Extension Specialist in Dairying during the past year has consisted mostly in aiding in organizing and supervising cow testing associations, teaching in extension schools and attending general community meetings at which dairying problems and organizations were discussed. The work during the past year has been of a slightly broader nature than in the past, due to the unprecedented growth of the State Farm Bureau and the development of the boys and girls' live stock club work.

July 1, 1919 there were thirteen cooperative cow testing associations in Michigan with a membership of 349 farmers owning 4205 cows.

Fourteen cooperative cow testing associations were active in Michigan July 1, 1920 and were as follows:

1. Kent County Cooperative Cow Testing Association.
2. Eaton County Cooperative Cow Testing Association.
3. Western Allegan County Cooperative Cow Testing Association.
4. Osceola County Cooperative Cow Testing Association.
5. Branch County Cooperative Cow Testing Association.
6. First Cloverland Cooperative Cow Testing Association.
7. Gogebic County Cooperative Cow Testing Association.
8. West Barry County Cooperative Cow Testing Association.
9. Emmet County Cooperative Cow Testing Association.
10. Van Buren County Cooperative Cow Testing Association.
11. St. Joseph County Cooperative Cow Testing Association.
12. Macomb County Cooperative Cow Testing Association.
13. Lapeer County Cooperative Cow Testing Association.
14. Wayne County Cooperative Cow Testing Association No. 2.

There were in these fourteen associations July 1, 1920, 367 members owning 4093 cows.

The association work has had, for the most part, a healthy growth during the past year. Six of the associations operating last year discontinued, new ones taking their places. Requests are coming in for assistance in organizing and for men to take charge. These requests are coming both from the older established dairy regions, especially the whole milk producing sections where dairy men desire to get records that will give them some idea of the cost of producing their product, and also from the newer dairy regions of the upper part of the lower peninsula and in the upper peninsula where the dairy industry is developing rapidly. There are six or eight counties at the present time planning to organize at least one association within the next six or eight months.

There is also considerable interest manifested in cooperative bull associations. No new bull associations have been organized during the year. Aid has been given several of the existing associations.

It would have been impossible to have carried on the cow testing association work during the past year without the loyal support of the county agents in the respective counties where the associations are located. It is becoming impossible, because of the limited size of the force and from the fact that the work is wide spread, to give it more than general supervision from this office together with aid in the securing and training of men to take charge of the work. The existence and successful operation of these associations is due in a large part to the loyal support and timely aid of the county agents in the counties in which they are located.

Extension Schools: Instruction was given in three two-day and thirty-two one-day extension schools by the extension specialist in dairying during the winter.

Total attendance..... 2861

Total number of lectures given..... 48

The following table gives a brief summary of the field work of the extension specialist in dairying, other than extension schools from July 1, 1919, to July 1, 1920.

	Meetings attended.	Attendance.	Meetings addressed.	Attendance at meetings addressed.
Conventions: District.....	1	90		
Conventions: State.....	1	500		
Local: Cow Testing Association.....	21	650	21	650
Local: Bull Associations.....	2	59	2	59
Local: Breeders' and Dairymen's Association.....	5	369	5	369
Local: Creamery.....	2	200	2	200
Local: Condensary.....	1	275	1	275
Local: Market Milk.....	3	146	3	146
Local: General Farmers and Business Men.....	13	547	13	547
Demonstrations: Judging.....	9	875	9	875
Exhibits: State Fair, Hillsdale Co. Fair, Farmers' Week M. A. C. (Estimated attendance at exhibits).....	3			25,000
Fairs: Local.....	1	25	1	25
Contests: Dairy Cow, 2 Fairs Allegan and Cadillac (Estimated attendance at contests).....				8,000
Conferences: District County Agents.....	11	166	11	166
Conferences: Cow Testers.....	21	607	21	607

Farm Visits Made: 283.

J. A. WALDRON.

East Lansing, Mich., June 30, 1920.

REPORT OF THE EXTENSION WORK IN HORTICULTURE.

The work has been carried out similar to previous years except that more emphasis is being put on the demonstrational phase of orchard and vineyard fertilization.

The time of the specialist was taken from October 7th to January 1st by the Horticultural department to meet the emergency need of an instructor. This interfered somewhat with the field work plans. Most of the work is done in cooperation with the county agricultural agents. The Horticultural department is assisting by furnishing most of the commercial fertilizer used in demonstrations. The Fennville Fruit Exchange is assisting by furnishing fertilizer used in local orchards. Some of the owners furnish material as well as the plot and necessary attention. Better work could be done and more accurate results obtained were the extension specialist able to have funds for material used in demonstrations and be responsible for its efficient employment.

What is known as farm visits do not accomplish ordinarily a wide-felt benefit. Hence they are not encouraged, but some are necessary to get a working knowledge of the industry in each section. Numerous requests are made for such visits. Such have to be refused or delayed. Unless some other way of handling such service is devised it will continue to take much time from constructive demonstration.

ORCHARD FERTILIZER DEMONSTRATIONS.

Kind fruit.	Benzie County.	Allegan County.	Van Buren County.	Berrien County.
Apple.....	1	3	1	1
Pear.....		1		1
Peach.....	1	1	1	1
Cherry.....	1	1	1	
Grape.....			2	2
Brambles.....		1		1

Two of the vineyard plots were started last year. The rest were started this year and are planned to run three years. Notes are kept on character of growth, and crop records as well as trunk measurements when possible. Usually thirty trees are under treatment and the plan is to provide a place where all interested growers can observe the use of nitrate, phosphate and potash. In some cases different cover crops are used. Sixteen days work in the field were taken of the specialist's time this spring and he was actively assisted by the county agricultural agents.

PRUNING DEMONSTRATIONS.

These were held at twenty-two different places with an attendance of 177. They are essentially schools and so far have not been held for follow-up work.

LANDSCAPE DEMONSTRATIONS.

These are to encourage the planting of the ground about farm homes. Sketches of plans and the needed shrubbery are prepared. During the spring these plans are followed out with the assistance of the specialist. This is an important service but cannot be developed without more help. Eight were handled this season.

PACKING DEMONSTRATIONS.

But two such schools were held. They need an advance trip to make proper preparations in order to be successful. Six days were spent attending horticultural meetings of various kinds where no lecture was given.

Three monthly news letters have been sent out since January to county agents and fruit associations. Four special articles for farm bureau papers were sent out. One circular on grape culture was written but has not been published. Nine days were taken to judge the fruit exhibits at five different fairs. This is valuable experience for the specialist. There should be a school arranged by fair officials to allow the judge to give instructions relative to making proper exhibits of the various fruits.

SUMMARY.

Farm Visits	136
Demonstrations, (all kinds)	53
Attendance at Demonstrations not including orchard culture	216
Lecture meetings	34
Attendance at lectures	4175

J. T. PICKFORD.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK WITH POTATOES AND VEGETABLES.

Potatoes: The extension work with potatoes was carried on during the fiscal year beginning July 1st, 1919 in much the same manner as heretofore. Mr. H. C. Moore who was on leave of absence to engage in war work returned and assisted in the potato work during the year.

Emphasis was placed on potato seed plot work and on keeping records of the work.

Briefly stated, the object of this work is to encourage such practices as will help to bring about:

1. Lower cost of production.
2. Better quality seed and table stock.
3. More stable markets and uniform prices.
4. Greater net profit for the growers.
5. Greater value, per dollar invested, for the consumer.

Some of the specific things which we have encouraged with a view of bringing about the desired results are:

- (a) Hill selection of tubers for seed.
- (b) The planting of seed plots.
- (c) Green or sun sprouting of the seed.
- (d) Seed treatment to prevent scab and black scurf (*rhizoctonia*).
- (e) Making comparative tests of seed secured from different sources.
- (f) More general and judicious use of commercial fertilizers.
- (g) Closer planting on rich soils to increase the yield and lower the cost of production per hundred pounds.
- (h) More common and more thorough use of Bordeaux.

Cooperation. The potato work has been carried on in cooperation with the county farm bureaus and with the Michigan Potato Exchange.

The county agents secured the men with whom the work was done. They also assisted with the work and in getting us to and from demonstration fields and places where meetings were held.

Field Demonstrations and Meetings.

There were 71 field demonstrations held during the year with an attendance of 543. The rather small attendance at these meetings was due largely to the shortage of help on the farms. There were 456 farms visited for specific purposes.

Lectures.

There were 53 lectures given during the year with an attendance of 4,084. This includes the extension schools, institutes, and special meetings.

Standardization of Varieties.

Much progress has been made in getting growers, especially those who are members of the Michigan Potato Exchange to grow only the Late

Petoskey (Petoskey Golden Russet) variety. Much time was spent in locating fields of this variety which could be recommended for seed. Many of the associations planted seed plots under the supervision of the county agents and extension specialists. The seed from these will be used for distribution to the various members of the associations who do not have good seed of their own.

Seed Certification.

The certification of potatoes has become a necessity in Michigan. Mr. Moore and myself are developing this line of work in cooperation with the Michigan Potato Producers' Association.

Vegetable Work.

The fact that the writer is Organization Secretary of the Vegetable Growers' Association of America has necessitated the giving of much time and study to vegetable growers' problems and especially those having to do with methods of organization. A plan of federating the various state and local associations with the National has been worked out. This plan includes cooperation with the National Farm Bureau Federation and with such state and county farm bureaus as wish to cooperate.

Special Work with Pea Growers.

There developed a demand for special work with the pea growers and especially those who grow peas for the canneries. Mr. Moore has given this work special attention. It consists of demonstrations with variety and fertilizer tests and in the securing of cost of production records.

Correspondence.

The amount of correspondence handled by this office had developed to such an extent that a full time stenographer became a necessity.

Publications.

A large number of special articles have been written for agricultural papers. Timely articles have been prepared and mailed to county agents or sent to State papers through the publicity department of the College.

Potato Work in the Upper Peninsula.

Mr. Moore and the writer spent a week in the Upper Peninsula. The work there has been supervised by J. W. Weston who has kept in close touch with this office.

C. W. WAID.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK IN MUCK CROPS

The activities of the extension work in muck crops is differentiated into two phases. (1) Assisting the farmers engaged in farming muck land with the special questions which his distinct type of agriculture presents. (2) To stimulate an interest in muck soil and reveal the potentialities of the large swamp acreage in Michigan which is at present undeveloped and of little value.

To properly articulate this year's work with that of the previous year it is necessary to review briefly the problem as a whole.

The agricultural utilization of muck and peat soils presents a completely distinct premise from that of the reclamation and utilization of virgin upland soils. This has been discussed more fully in a paper read at the annual meeting of the American Peat Society September, 1919.* It emphasized the fact that muck farming in any of its phases could not be carried on from a point of view based on upland experience. Muck and peat soils, organic in origin, with an excess of organic matter and nitrogen bearing substances, deficient in mineral content, chiefly phosphorus and potassium, undergoing rapid change physically, chemically and biologically are not only distinct but present features almost contrary to the characteristic features of the average upland soil. The causes for failure in muck farming have in many instances been due to a lack of appreciation of these facts. It is evident that the entire system of farm management and soil handling must be different from upland practices. Not only are the ordinary farm practices unique in muck farming but the crop varieties, as corn, oats and hay adapted to the upland are usually not suitable for the muck.

For a more complete analysis of this point of view the paper mentioned above may be consulted.

An extension worker dealing with a new field of agriculture with unique and special problems concerning which the published practical information is very limited, speedily became a medium for the exchange of profitable experiences and methods and questions concerning every phase of this type of agriculture. This made it necessary to organize the Michigan Muck Farmers Association in 1919, which held three well attended semi-annual meetings. The development and results derived from the organization are made the subject of a main part of this report because unquestionably the most effective part of the extension work in assisting muck farmers is being carried out through this organization. In February, 1920, a three day meeting was held. The program was chiefly made up of papers given by muck farmers with whom this office had been cooperating. The first day was given to the use of muck as a fertilizer. The second and third days were given to a discussion of Muck Farm Management. Professor A. J. Alway University of Minnesota, gave two addresses. The benefits of the organization beyond the educational value are deserving of mention. The members of the association have been a fruitful source of information for the extension

*Muck Farm Management in Michigan. Journal American Peat Society, July, 1920.

worker, on the most profitable and advisable systems of muck farm management in various parts of the State. The importance of first hand information on a subject which has a scanty literature, availability of experiences and observations of successful men which otherwise would be lost, the contact with ideas and traditions of the men engaged in the work in which the interests of the extension worker live, all have been made possible by the Michigan Muck Farmers' Association.

The influence of an organized group of men with kindred interest makes possible a valuable coordinated influence for worthy agricultural legislation. Lastly, it is important to note, that all the experimental and demonstration work carried out on muck was very easily and simply arranged with members of the Association whose confidence had been secured. Thus in each community they became representatives of the extension office and of their organization.

The results of the demonstrations last year were unsatisfactory due to the continued hot dry spell which was general in this State, but a number of interesting facts were noted affirming the previous year's experience.

These are briefly given. The value of field peas as frost resistant legumes, the sunflowers as a frost resistant plant for silage, the soy bean as a rapid growing hay crop, the value of rye as a grain where muck is properly handled, the importance of thorough rolling, as an important practice on muck lands; the importance of hay and sugar beets as cash crops for muck soil, the value of vetch as a spring or fall planted legume; the factors governing drainage of different types of muck.

A very small part of the muck lands of Michigan, less than one per cent, is being utilized. A very small percentage of these areas is being intensively cultivated. While a large part of the extension work is among the intensive celery, onion and mint growers, the future development of Michigan muck lands lies in the handling of these soils from an extensive point of view. The problem is largely to ascertain the plan for farming muck lands profitably, in growing staple standard crops and not special risky vegetable crops which are easily overproduced. Thus, special attention has been given to the question of farm management and acquainting muck farmers with the profitable practices of other muck farmers. A safe system of farm management for muck land has been evolved. An outline is given in the published article mentioned above, beef or dairy cattle, oats and peas, corn, or sunflowers for silage, beets and hay as cash crops. The most important and most valuable crop for which the muck lands of Michigan can be adapted is the sugar beet. Careful observations and information of value have been extended to muck farmers relative to the fertilization, the handling of the muck for sugar beet production of high sugar content. At the time of this writing a visit to the field of L. C. Robart at Eaton Rapids revealed numerous plants with beets weighing a pound or more. This crop represents a demonstration in the sense that the writer was responsible for the direction for planting and the fertilization of this crop.

Demonstrations are now being carried on to point out the fertilizer needs and suggested crops to fit into a plan for extensive muck farm management on different types of muck: Crosswell, Brown City, Traverse City, Bitely, Niles, Eaton Rapids. The crops are selected varieties, of course adapted to muck: Sunflowers, soy beans, beets, Japanese millet, selected varieties of corn, field peas.

Demonstrations to determine fertilizer requirements are being carried out on intensive crops.

- 4—Kalamazoo, celery.
- 4—Portage, celery.
- 1—Croswell, spinach, beets.
- 1—Leslie, onions, celery.

It is recognized that the value of these lands must be proved before capital will become interested in the reclamation of our large muck areas. Considerable attention has been given to the accumulation of data of value to development projects—the special type of drainage machinery, and the methods of clearing and breaking up these soils economically. It is assumed that every possible encouragement should be given to men interested in the development of this tremendous resource which is now practically unused.

It is evident that there should be a source of information and advice on the various types of muck in Michigan to protect buyers who desire unbiased advice and to encourage prospective development. This office has functioned in this capacity by collecting information and giving advice on reclamation projects.

Data has been accumulated for the immediate publication of a bulletin on the handling of muck soils and muck crops.

EZRA LEVIN.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK IN ENTOMOLOGY.

The work of the extension specialist in Entomology has consisted almost exclusively of giving advice and aid in control of insect enemies of agriculture. Much of this has been in response to requests and the remainder has been in cooperation with county agents in the various parts of the State. Much of the time the effort has taken the form of making addresses at granges, extension schools, and meetings of farmers, wherever the demand or the outlook made it seem profitable.

During the last half of the summer of 1919 much attention was paid to a search for European corn-borer. Different districts which might have been accidentally infested in the past and overlooked, were visited, in an effort to locate areas of infestation, should any exist. Following this, in view of the fact that the Hessian-fly is on the increase in Michigan, efforts were made to induce farmers to sow their wheat on a fly-free date, especially in the southern part of the State. At the same time the search for the corn-borer was kept up.

Immediately after the winter set in, efforts were made by personal visits to influence the Supervisors in the northern counties, through the county agents, to prepare for the coming grasshopper campaign in 1920, by supplying themselves with poison at a time when the price was down; and in due course much effort was expended during the spring and early

summer of 1920 in encouraging and forwarding the suppression of the grasshopper epidemic by directing the work and supplying directions for treatment.

At intervals during all this time trips have been made to give special advice in cases of difficulty in orchards, in the flour-mill, in greenhouses, and in several cases where white ants were injuring dwellings.

During the winter and early spring, arrangements were made for the establishment of observation stations for the purpose of making records of the time of flight of the second generation of the codling moth.

During Farmers' Week the entire time was expended in trying to be helpful to visiting farmers both by word, and by explaining exhibits which were planned to educate the growers to new insects or to new facts concerning old pests.

Yours respectfully,

R. M. HAIN,

Extension Specialist in Entomology.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK IN APICULTURE.

This has been a good year among the beekeepers of Michigan, especially in an educational way. The old is passing and the new is coming. The "side line" beekeeper is passing and an increasing number of persons are making beekeeping a specialty. The so-called "box" or crossed-comb hive has been outlawed, and many colonies of bees have been transferred into modern hives. Many beekeepers have been instructed during the year how to treat diseased colonies and to apply better methods.

At the State Fair at Detroit an exhibit from the Michigan Agricultural College was made and talks on beekeeping and answers to questions given.

The greater part of the year was taken up with field work, visiting beekeepers, holding meetings for beekeepers and giving demonstrations of best methods.

During nine months of the year two hundred and twenty-five farms and owners of bees were visited. Twenty-four county and other meetings were held. Twenty-three addresses were given, the whole attendance at these meetings being five hundred and sixty-five. For three months during the winter, time was largely given to holding county bee schools, two days in a county. Twenty-five counties were thus visited. The total attendance at these schools was three hundred and eighteen, with three hour sessions each in the morning and in the afternoon, given to the important questions in beekeeping.

Two meetings of State Beekeepers' Association were attended.

Two county fairs were visited with exhibits, where many questions were considered.

Thirty-five counties of the State now have beekeeper's organizations through which meetings and other interests are considered.

The year began with drouth conditions in many parts of the State

and the winter was long and severe, with heavy losses, which somewhat lessened the number of beekeepers, but those who are really interested are coming to see the value of a specialized industry. Our policy is to "make better beekeepers" and to utilize the splendid nectar resources of Michigan.

Like all educational processes it takes time to see results. It takes time to build the great honey production industry which we should have.

Respectfully submitted.

EDWIN EWELL,

Extension Specialist in Apiculture.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK IN FORESTRY.

There has been a good healthy interest shown all over the State in the forestry work. Farmers were calling on this office continually for assistance in the care and management of their farm woodlands and in marketing of the products cut from them. The assistance given along this line has perhaps been the most outstanding piece of extension work carried on this year.

Two State conferences were attended, and the Forestry Project was presented to the county agents. Personal service was provided for county agents and communities where particular interest was shown along forestry lines.

A community tree planting project was started, and ten acres of light rolling land was planted to white pine. The project was led by the county agent who had the cooperation of the high school teacher and the high school boys. The students assisted in the planting work for two days and incorporated the data collected into their agricultural project for the year.

Exhibits were shown and demonstrations carried on at the Michigan State Fair and the Western Michigan Fair. The booths were well attended, and a great deal of interest was shown in the tree planting and the windbreak projects. This latter project is being favorably received by farmers, and the next few years will see many windbreaks started on Michigan farms.

The problems on the control of shifting sands are still commanding the attention of the county agents and this office, and the coming spring will see the follow-up work continued on the Harlem Demonstration in Ottawa county and on the Loss Demonstration in Muskegon county. Several other communities have requested this office to conduct demonstrations of a like nature.

The culture of basket willows promises to be a good source of income for farmers owning pieces of land which are too wet to farm. Already several communities have made arrangements with their county agents for work on this project.

SUMMARY.

Conferences with College Departments.....	20
State Conferences	2
County Conferences	48
Acres in farm woodlands visited.....	979
County Agents assisted	19
Counties worked in	26
Farms visited	87
Talks made	9
Attendance at talks	190
Demonstrations held	8
Attendance at demonstrations	78
Sand dunes visited (acres)	125
Letters written	340
Office calls	25

Respectfully submitted,

E. C. MANDENBERG,

Extension Specialist in Forestry.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK IN POULTRY HUSBANDRY.

The report of extension work in Poultry Husbandry herein submitted, extends over a period of five and one-half months. Leave of absence was granted the present extension specialist from October to mid April. The type of work conducted during the balance of the year has been limited largely to farm flock culling demonstrations. The increasing demand, among our farmers for a practical knowledge of the characteristics that constitute both profitable and non-profitable hens has created state wide interest in this culling work. The summer and fall months are devoted almost entirely to this form of extension work, because of the economic advantages of disposing of unproductive hens immediately upon the completion of their laying cycle and also because of the fact that certain physical tests are only applicable during this period.

In endeavoring to comply with the large number of requests from the county farm bureaus for demonstrations it was found necessary to allot only two days to each county. Obviously each county must have a definitely organized program to use the specialist's time to greatest advantage. In most cases the specialist, in cooperation with the county agent, would hold a meeting in each township. This provided an opportunity for training a leader in each township to do follow-up work assisted by the county agent where necessary. The specialist in order to work most effectively arranged his itinerary so that a greater amount of territory could be covered by introducing the work in the southern counties first and migrating north with the march of season. Thus a

systematic campaign was conducted, the specialist arranging the State schedule and the county agricultural agent conducting a systematic campaign by townships within the county.

The actual number of unprofitable hens existing in our farm flocks averaged very closely to 30%. In view of the fact that Michigan has an aggregate of more than thirteen million hens and in view of the further fact that it now costs approximately \$2.50 a year to maintain a hen, only then can the importance of this work be realized.

While the culling demonstrations are made the major project, all other farm poultry problems receive due recognition and attention. The opportunity for suggesting environment as a factor in egg production presents itself at the close of each demonstration.

LITERATURE.

An extension poultry bulletin on the "Culling of Hens and Chicks" has been published and many thousands of copies circulated. Mimeograph copies of laying rations, chick rations and other literature, dealing with farm poultry problems have been furnished all agricultural agents in the State for distribution.

DEMONSTRATION FARMS.

The poultry demonstration farms inaugurated two years ago, are still in operation, furnishing valuable data on the cost of production, and other information of value to every poultry producer. As a result of this culling work state wide enthusiasm is being manifested in utility poultry. Breeders are anxious for open competition in egg laying contests. By means of such contests the best poultry interests in the State can only be served.

Summary of work performed during 5½ months of past fiscal year.

	No.	Attendance	Average
Farm Visits	422		
Poultry Culling Demonstrations....	252	5305	21
Lecture meetings	9	668	74
Fairs (Utility poultry judging).....	2		
Demonstration Farms	32		
Counties visited	46		
People served		5973	

E. C. FOREMAN.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION SPECIALIST IN POULTRY.

July

47 culling demonstrations with an attendance of.....	342
The work took place in Allegan, Kent and Saginaw.	
1 meeting was canceled.	
2 days were spent in the office.	
7 days vacation.	
Total attendance at meetings.....	342

August

7 culling demonstrations with attendance of.....	32
4 lectures with attendance of.....	115
2 canning demonstrations with attendance of.....	54
2 days spent in charge of laying contest at State Fair.	
12 days spent in office.	
Total attendance at meetings.....	201
The work took place in Kent, Wayne and Ottawa counties.	

September

13 culling demonstrations with an attendance of.....	188
1 farm visit.	
3 lectures with an attendance of.....	55
4 days spent in the office.	
Total attendance at meetings.....	243
The work took place in Manistee, Sanilac, and St. Clair counties.	

October

34 culling demonstrations with an attendance of.....	547
4 lectures with an attendance of.....	46
10 days spent in office.	
Total attendance at meetings.....	593
Work took place in Barry, Allegan, Jackson, Kalamazoo, Hillsdale, Saginaw, Kent and Berrien counties.	

November

6 days spent in attending conference of Home Demonstration Agents.	
2 canning demonstrations.....	42
3 culling demonstrations.....	45
4 lectures	65
1 day spent in judging at boys' and girls' club meeting.	
1 meeting canceled.	
6 days in office.	
Total attendance.....	152
Work took place in Sanilac, Wayne, Saginaw, Berrien and Washtenaw counties.	

December

7 culling demonstrations.....	118
3 lectures	54
5 days spent in the office.	
6 days vacation.	
Total attendance at meetings.....	172
The work took place in Monroe, Washtenaw, Ottawa, Oakland, Manistee, Kent, Allegan counties.	

January

2 culling demonstrations, attendance.....	10
1 lecture	10
3 meetings canceled.	
4 days Secretary to Judge at Detroit Poultry Show.	
12 days in the office.	
Work took place in Wayne, Washtenaw, Ottawa counties.	
Total attendance	20

February

4 lectures with attendance of.....	550
12 days in the office.	
Work took place in Manistee and Monroe counties.	

March

9 lectures	408
1 culling demonstration.....	5
12 days in the office.	
Total attendance at meetings.....	413
Work took place in Newaygo and Branch counties.	

April

15 lectures	284
10 days spent in the office.	
8 days ill.	
Total attendance at meetings.....	284
Work took place in Antrim, Sanilac, Kent and St. Clair counties.	

May

2 lectures with an attendance of.....	117
3 farm visits.	
11 days in the office.	
Total attendance at meetings.....	117
Work took place in Kent, Branch and Berrien counties.	

June

3 lectures with an attendance of.....	42
16 days in office.	
10 days vacation.	
Total attendance	42
Work took place in Wayne county.	

Total

114 culling demonstrations.	
48 lectures.	
4 canning demonstrations.	
Total attendance at meetings.....	2129

Counties visited: Allegan, Kent, Saginaw, Wayne, Ottawa, Manistee, Sanilac, St. Clair, Hillsdale, Berrien, Washtenaw, Monroe, Branch, Nwaygo, Antrim, Barry, Kalamazoo, Jackson.

ANNABEL CAMPBELL,

Extension Specialist in Poultry.

East Lansing, Mich., June 30, 1920.

REPORT OF EXTENSION WORK IN HOME ECONOMICS.

The extension work in home economics has been carried on the past year by three specialists. One in foods, one in clothing and one in household management. The household management specialist has acted also as State Leader with one assistant located in the Upper Peninsula. During July and August additional help was employed to assist with the canning work. The health specialist also remained with us until August 15.

The Home Economics Extension section has tried to be of service at all times by:

- (1) Assisting the home demonstration agents in furthering their work by providing them with all new technical information, helping to plan projects and also helping to carry them out.

- (2) Assisting the county agricultural agents who were interested in bettering the home conditions by giving to the women of their counties instruction and help in all matters pertaining to the home.

Contrary to previous custom, each specialist this year has confined her efforts entirely to her one line of instruction. We have found this plan much more satisfactory. More intensive work has been done and much more accomplished.

The following projects have been carried on:

Foods: Coral Havens, Specialist.

Canning: Although it might seem with the previous campaigns in canning that nearly all of the State of Michigan would have been reached still many communities asked for the canning demonstration and all of July and August was devoted to this work.

Nutrition: The following subjects were taken up at the Extension School and in response to calls for single talks and demonstrations.

- (1) "How Our Food Affects Our Health."

Talk on fundamental principles of human nutrition which should be of interest and value to both men and women.

- (2) "The Stuff That Sturdy Children are Made Of." Lecture or lecture and demonstration.

- (3) "Liquid Meat." Demonstration lecture on use of milk and cheese as meat substitutes.

- (4) "Can We Live Better and Spend Less." Demonstration lecture on planning of balanced meal from Michigan farm products.

Milk Campaigns: From the last of February until the last week in May the time was devoted to milk campaigns or at least stressing the use of milk.

Two quite intensive campaigns were held. One in Wayne county and one in Kalamazoo county. These were the first county wide campaigns attempted in the State.

The preliminary work consisted of a number of articles about milk and dairy products being published in the county newspapers. Also through the cooperation of the county school commissioners questionnaires were sent to the rural schools with the idea of getting information as to the amount of milk used by the school children. The results of the questionnaires were tabulated and incorporated in a folder which told in simple language the value of milk in the diet.

The campaign was then carried on by means of posters, exhibits, talks to women's clubs, granges and farmer's clubs. Also talks to students in public schools in the villages and small towns in the counties.

In one county in the Upper Peninsula the value of milk was brought before the people by means of a play "Milk Fairies," which was given by the small children in one of the schools. Many stories were told of the effect it had upon the children who had been in the habit of drinking tea and coffee.

Clothing: From July 1 to August 15, the time of the specialist was spent at Chicago University taking special work along the line of clothing.

In the fall assistance was given the home demonstration agent in putting on clothing exhibits.

The following subjects were taken up at the extension schools and in response to calls for single talks and demonstrations.

- (1) "Choosing a Becoming Color."
- (2) "Selection of Patterns. How to Camouflage the Defects in the Figure by Good Lines."
- (3) "Selection of Materials. Some Simple Tests for Adulterations."
- (4) "The Use and Alteration of Commercial Patterns."
- (5) "The Sewing Machine and Its Attachments."
- (6) "Care and Renovation of Clothing."
- (7) "Children's Clothing."
- (8) Remodeling, "Cleaning and Dyeing."
- (9) "The Clothing Budget."

The specialist was appointed on an advisory committee to act with the committee on the Standardization of Textile Fabrics from the American Home Economics Association.

Questionnaires were handed out at meetings and also sent to the home demonstration agents for their distribution with the idea of getting information on the purchasing habits of women.

Samples of worn garments were also obtained from the women for the purpose of finding out the actual wearing qualities of materials as compared with cost.

Much interest has been shown in the clothing work this year due undoubtedly in part to the poor quality of material on the market and the high prices asked.

Household Management: This work was not begun until October first.

The following subjects were discussed at extension schools and in response to calls.

(1) "System in Housework." Plans and methods of doing housework.

(2) "The Model Kitchen." This included the remodeling and managing of the kitchen to reduce the daily work.

(3) "Labor Saving Devices" as

(a) Water in house

(b) Ice chest or refrigerator

(c) Motor washer

(d) Vacuum cleaner

(e) Fireless Cooker

(f) Wheel tray or table

(g) Dish drainer and many other small conveniences.

(4) "Keeping and Making a Study of Household Accounts." Several calls have been answered throughout the year to assist in remodeling old kitchens to make them more efficient.

Fairs and Exhibits: No judging was done at fairs this year as has been customary in previous years. However help was given in planning educational exhibits for several fairs. The specialist assisted also in putting up and arranging five exhibits.

Conferences: Two conferences for home demonstration agents were held at which the specialists gave the major part of the work. This consisted of outlining projects for the year, and assisting agents in preparing illustrative material.

Specialist also assisted at a Housewives' Conference held during Farmers' Week.

Following is a summary of the work given and numbers reached:

Extension Schools	Meetings	Attendance
Foods	14	597
Clothing (Arm's)	34	897
Clothing (Potts)	12	687
Household Management	28	2,063
Single Talks and Demonstrations		
Foods—		
Canning	25	967
Nutrition	3	62
Child Feeding	6	295
Milk	19	690
Picnic	1	2,500
Clothing	26	1,006
Household Management	12	347
Picnic	1	3,000
Organization	19	1,401
Milk Campaigns	2	1,770
Fairs	5	10,000
Total		26,283

Bulletins: No new bulletins have been published this year by this section. Reprints were made of several of the old bulletins with slight revision.

Mimeographed copies of "Some Suggestions for Good Meal Combinations," "Color", were used to supplement lectures and other bulletins. A reprint of the Home Account Book has also been made.

Statistical Report Home Economics Extension School, July 1, 1919, to June 30, 1920

FOODS—MISS HAVENS.

County.	Place.	Attendance.
Macomb.....	Romeo.....	100
Van Buren.....	Hartford.....	40
Ingham.....	Lansing.....	50
Kalamazoo.....	Alamo.....	25
Kalamazoo.....	Vicksburg.....	30
Kalamazoo.....	Smith's Schoolhouse.....	20
Kalamazoo.....	Portage.....	35
Kalamazoo.....	Otsego.....	75
St. Joseph.....	Three Rivers.....	35
Wexford.....	Manton.....	14
Wexford.....	Manton.....	48
Kalamazoo.....	Vicksburg.....	25
Kalamazoo.....	Kalamazoo.....	75
Kalamazoo.....	Damon Church.....	25
Total.....		597

CLOTHING—MISS ARMS.

County.	Place.	Attendance.
Branch.....	Coldwater.....	125
Wayne.....	Cherry Hill.....	7
Wayne.....	Belleville.....	8
Wayne.....	Belleville.....	15
Schoolcraft.....	Manistique.....	12
Gogebic.....	Wakefield.....	15
Dickinson.....	Iron Mountain.....	15
Dickinson.....	Quinnesec.....	15
Houghton.....	Quincy.....	9
St. Clair.....	Port Huron.....	17
St. Clair.....	Port Huron.....	17
St. Clair.....	Allenton.....	19
St. Clair.....	Allenton.....	19
Washtenaw.....	Ypsilanti.....	66
Washtenaw.....	Ypsilanti.....	75
Wayne.....	Dearborn.....	15
Wayne.....	Dearborn.....	34
Wayne.....	Cherry Hill.....	15
Wayne.....	Cherry Hill.....	30
St. Clair.....	Memphis.....	23
St. Clair.....	Memphis.....	24
St. Clair.....	Memphis.....	40
Clinton.....	Ovid.....	40
Lenawee.....	Jasper.....	20
Allegan.....	Allegan.....	200
Allegan.....	Allegan.....	15
Allegan.....	Gun Plains.....	10
Allegan.....	Gun Plains.....	20
Allegan.....	Hamilton.....	16
Branch.....	Coldwater.....	32
Branch.....	Coldwater.....	41
Branch.....	Coldwater.....	14
Branch.....	Coldwater.....	75
Total.....		898

Statistical Report Home Economics Extension School.—Concluded.

CLOTHING—MISS POTTS.

County.	Place.	Attendance.
Marquette.....	Marquette.....	15
Schoolcraft.....	Manistique.....	50
Houghton.....	Houghton.....	50
Houghton.....	Trap Rock.....	16
Houghton.....	Chassell.....	50
Schoolcraft.....	Cooks.....	40
Schoolcraft.....	Hiawatha.....	40
Schoolcraft.....	Marblehead.....	25
Marquette.....	Marquette.....	35
Houghton.....	Tapola.....	200
Marquette.....	Marquette.....	6
Marquette.....	Marquette.....	100
Marquette.....	Witbeck.....	16
Marquette.....	Witch Lake.....	28
Marquette.....	Marquette.....	5
Marquette.....	Marquette.....	11
Total.....		687

HOUSEHOLD MANAGEMENT—MISS SMITH.

County.	Place.	Attendance.
Kalamazoo.....	Richland.....	28
Kalamazoo.....	Texas.....	48
Kalamazoo.....	Fulton.....	54
Kalamazoo.....	Trafford School.....	28
Clinton.....	Eagle.....	48
Kalamazoo.....	Vicksburg.....	16
Allegan.....	Hopkins.....	21
Wayne.....	East Nankin.....	30
Wayne.....	Beech.....	40
Wayne.....	Plymouth.....	35
Allegan.....	Fennville.....	50
Allegan.....	Martin.....	45
Allegan.....	Wayland.....	36
Manistee.....	Kaleva.....	500
Allegan.....	Otsego.....	61
Barry.....	Middleville.....	96
Barry.....	Orangeville.....	32
Barry.....	Cressy.....	125
Menominee.....	Menominee.....	26
Menominee.....	Menominee.....	125
Gogebic.....	Wakefield.....	24
Wexford.....	Meick.....	29
Wexford.....	Buckley.....	45
Total.....		2,063

Statistical Report Single Talks and Demonstrations, July 1, 1919, to June 30, 1920.

FOODS—MISS HAVENS.

County.	Place.	At- tendance.	Subject.
Washtenaw	Ann Arbor	6	Canning.
Washtenaw	Clinton School	30	Canning.
Washtenaw	Home of Miss Gordon	25	Canning.
Washtenaw	Burns Park	25	Canning.
Washtenaw	Gager School	15	Canning.
Wayne	Cherry Hill	25	Canning.
Wayne	Home	15	Canning.
Wayne	Inkster	12	Canning.
Manistee	Bear Lake	2,320	Picnic.
Ogemaw	West Branch	25	Canning Demonstration.
Wayne	Detroit	500	Vegetable Grower's Association.
Cass	Marcellus	25	Food.
Cass	Barron Lake	30	Food.
Kent	Wyoming Park	77	Food.
Allegan	Otsego	12	Child Feeding.
Allegan	Fish Community	15	Child Feeding.
Ingham	Haslett	93	Hot Lunches.
Ingham	Stockbridge	25	Child Feeding.
Ingham	Stockbridge	125	Child Feeding.
Ingham	Williamston	25	Child Feeding.

FOODS—MISS HUGHES—JULY AND AUGUST.

County.	Place.	At- tendance.	Subject.
Manistee	Manistee	13	Canning.
Barry	Lacey	13	Canning.
Barry	Rutland	8	Balanced Meal.
Barry	Woodland	8	Canning.
Newaygo	Newaygo	15	Canning.
Oakland	Leonard	41	Canning.
Oakland	Waterford	25	Canning.
Van Buren	Locota	35	Canning.
Van Buren	McDonald	25	Canning.
Lapeer	Brown City	20	Canning.
Lapeer	Burnside	20	Canning.
Lapeer	Columbiaville	18	Canning.
Benzie	West Plain	6	Canning.
Benzie	Crystal Ridge	6	Canning.
Benzie	Achas	16	Canning.
Iron	Crystal Falls	50	Milk.
Iron	Alpha	16	Milk.
Iron	Iron River	33	Milk.
Chippewa	Sault Ste. Marie	55	Milk.
Chippewa	Piekford	5	Milk.
Chippewa	Detour	18	Milk.
Chippewa	Rudyard	75	Milk.
Gogebie	Bessemer	25	Milk.
Gogebie	Wakefield	200	Milk.
Schoolcraft	Manistique	65	Milk.
Schoolcraft	Cooks Mill	20	Milk.
Schoolcraft	Whitdale	18	Milk.
Houghton	Otter Lake	75	Milk.
Houghton	Hubbel	35	Milk.
Total		4,157	

Statistical Report Single Talks and Demonstrations.—Concluded.

CLOTHING—MISS ARMS.

County.	Place.	Attendance.	Subject.
Rosecommon	St. Helen	30	Textiles and Clothing.
Rosecommon	Higgins Lake	50	Textiles and Clothing at Farmer's picnic.
Kent	Ada	7	First of series of lessons on clothing. Talked on "Choosing Becoming Colors."
Ottawa	Holland	17	"Renovating and Dyeing of Materials."
Kent	Ada	10	Second of series of lessons on clothing.
Ottawa	Holland	24	"Renovation and Dyeing of Materials."
Ottawa	Holland	170	"Development of American Dye Industry and Dyeing Materials."
Ottawa	Grand Haven	115	"Color in Dress."
Ottawa	Grand Haven	30	"Renovation and Dyeing of Materials."
Kent	Ada	7	"Selection of Pattern lines in dress."
Livingston	Howell	40	"Renovation of Clothing." To Farmers' Club.
Kent	Ada	7	"Selection of Materials."
Kent	Ada	17	"Use of Patterns."
Kent	Ada	17	"Care and Renovation of Clothing, Dyeing and Remodeling."
Branch	Coldwater	125	"Color in Dress." To Parent-Teachers Assn.
Kent	Ada	7	"The Clothing Budget" and reviewed work of entire series.
Wayne	Dearborn	50	"Textiles."
St. Clair	China	16	"Color."
St. Clair	Memphis	13	"Use and Alteration of Patterns."
St. Clair	Yale	12	"How to Choose the Right Design."
Eaton	Grand Ledge	80	"Standardization of Textiles." Some filled out the questionnaire on purchasing habits.
Ingham	Lansing	40	"Planning the Costume."
Kalamazoo	Scotts	20	"Selection of Patterns."
Kalamazoo	Scotts	30	"Use and Alteration of Patterns."
Kalamazoo	Richland	50	"Selecting a Pattern." "Choosing a Becoming Pattern."
Livingston	Howell	30	"Clothing for Children." At Farmer's Club meeting.
Oakland	Higland	35	"Color."
Total		1,202	

HOUSEHOLD MANAGEMENT—MISS SMITH.

County.	Place.	Attendance.	Subject.
St. Clair		40	Home Convenience Tour.
Van Buren	Lacota	25	Home Convenience.
Clinton	Bath	35	System in Housework.
Antrim	Alba	35	System in Housework.
Antrim	Mancelona	6	System in Housework.
Chippewa	Sault Ste. Marie	21	System in Housework.
Ingham	Lansing	21	Budgeting.
Oakland	West Highland	75	System in Housework.
Wayne	Plymouth	8	Household Accounts.
Wayne	Bellville	11	Household Accounts.
Wayne	Sumpter	6	Household Accounts.
Ingham	Fitchburg	60	System in Housework.
Wayne	Dearborn	3,000	Home Convenience. (Picnic)

HEALTH—MISS PARKER—JULY 1—AUGUST 15.

County.	Place.	Attendance.
Dickinson	Loretta	3
Dickinson	Channing	12
Dickinson	Quinnesec	10
Dickinson	Metropolitan	10
Marquette	Michiganmore	38
Baraga	Covington	14
Baraga	Baraga	7
Baraga	Skaneateles	22
Baraga	Baraga	22
Total		121

STATE BOARD OF AGRICULTURE.

ORGANIZATION—MISS SMITH.

County.	Place.	Attendance.	Character of Work.
Allegan.....	Allegan.....	500	Picnic (Woman's Part in Town Bureaus).
Lapeer.....	Columbia.....	30	To organize an H. E. Club.
Kent.....	Wyoming Park.....	22	To help plan Club Year's Work.
Lenawee.....	Fruit Ridge.....	300	Explain H. E. Ext. work.
Wayne.....	Detroit.....	100	County Farm Bureau Meeting and Luncheon.
Washtenaw.....	Ann Arbor.....	400	Farm Bureau Meeting and Luncheon. "Woman's Work."
Washtenaw.....	Salem.....	65	Farmers' Club. "Woman's Work."
Washtenaw.....	Eaton Rapids.....	60	Ministers' Conference—H. E. Ext. Work.
St. Clair.....	Port Huron.....	25	County Meeting of Women.
Ottawa.....	Coopersville.....	75	County Meeting of Women.
Barry.....	Woodland.....	80	Co. Federation of Woman's Club. H. E. Ext. Work.
Manistee.....	Kaleva.....	7	Com. meeting to plan work for county.
Oakland.....	Waterford.....	12	To discuss plans for work in county.
Allegan.....	Allegan.....	55	County meeting of women.
Schoolcraft.....	Whitdale.....	63	Community meeting.
Total.....		1,294	

ORGANIZATION—MISS POTTS.

County.	Place.	Attendance.	Character of Work.
Menominee.....	Menominee.....	50	Plans made for women to carry on work with Parent-Teacher's Asso. and have round-up of exhibit of remodeled clothing at County Institute at Menominee.
Schoolcraft.....	Thompson.....	12	Home Demonstration Agent presented work on foods and plans with new agent were discussed by the assistant state leader.
Schoolcraft.....	Blaney.....	35	Women expressed their appreciation of work of the agent and voted to take up clothing project with new agent.
Schoolcraft.....	Manistique.....	10	Attended farm bureau meeting and presented situation of home demonstration agent work in county.
Total.....		107	

MILK CAMPAIGN OF WAYNE AND KALAMAZOO.

County.	Place.	Attendance.
Wayne.....	Flat Rock.....	30
Wayne.....	Redford.....	2
Wayne.....	Beech.....	50
Wayne.....	Wayne.....	26
Wayne.....	Romulus.....	60
Wayne.....	Northville.....	75
Wayne.....	Sheldon.....	25
Wayne.....	Dearborn.....	16
Wayne.....	Belleville.....	125
Wayne.....	Nankin.....	55
Wayne.....	Plymouth.....	28
Wayne.....	Cherry Hill.....	75
Wayne.....	Grosse Pointe.....	112
Kalamazoo.....	Climax.....	70
Kalamazoo.....	Schoolcraft.....	119
Kalamazoo.....	Cooper.....	49
Kalamazoo.....	Augusta.....	125
Kalamazoo.....	Comstock.....	75
Kalamazoo.....	Kalamazoo.....	140
Kalamazoo.....	Scotts.....	66
Kalamazoo.....	Vicksburg.....	59
Kalamazoo.....	Galesburg.....	190
Kalamazoo.....	Kalamazoo.....	209
Total.....		1,770

REPORT OF HOME DEMONSTRATION AGENT WORK.

July 1, 1919—June 30, 1920.

Due to lack of sufficient federal appropriations to maintain the work of the home demonstration agents in all counties where the work had been started it became necessary July 1, 1919, to reduce the number of counties employing agents to twelve, with no urban home demonstration agents.

Several new counties have asked for home demonstration agents for the coming year but no federal money seems to be available.

However in these twelve counties the work during the past year has assumed a very permanent form, with a strong backing of the women in every case.

The following projects have been carried on in the various counties: Organization; Foods, including canning, dietetics and milk campaigns; Clothing with its different phases; some Child Welfare; Household Management, especially home conveniences and home accounts; Poultry; and Girls' Club Work.

ORGANIZATION.

Under the old form of farm bureau the work of the women was naturally accepted as being on an equal basis with the men. With the new farm bureau there seemed to be no place for women's work in their program. However in nearly all counties having a home demonstration agent, and where the work is understood it has been assumed that the membership is a family membership.

This has not been officially recognized by the State Farm Bureau.

The following form of organization is being worked out:

In counties having home demonstration agents, a woman's committee is recommended in each township or community—to be composed of a chairman and four others. The chairman of this committee is to be elected by the women of the township or community and she selects the other members of the committee for her township.

The chairman of the various township committees at the time of the annual meeting of the county farm bureau, selects five of their members to act as a county committee of the home department of the farm bureau. The chairman of this committee serves on the executive committee of the county farm bureau.

FOODS.

Canning: Due to the season being rather dry last year and also to the fact that the majority of women are now familiar with the cold-pack canning not as many public demonstrations were given as usual. The agents did more personal work assisting women in their homes who had previously had trouble with their canning or often times a few neighbors were invited into a home and the day spent in canning. This was really much more helpful than the old plan. The interest in the canning of meat and poultry has grown very rapidly this last year.

Dietetics: Food study classes or dietetics classes were held in nearly every county. There often times followed Red Cross nursing classes. They consisted of a series of lessons varying from four to fifteen depending upon the community and the amount of time the women could give.

Milk. Several of the agents have been doing special work with milk especially in connection with child feeding. They have urged the necessity of milk in the diet of the small child. It is appalling the number of mothers who give their children only coffee and tea to drink and then wonder why they do not grow. In several towns, a woman's organization has been persuaded to provide milk for the school children. This to be served during the forenoon and afternoon. A marked change has always been noticed in the amount of work the children have been able to do, and usually quite a gain in weight.

Four counties have put on real campaigns, putting up exhibits, writing publicity articles for newspapers and giving talks and demonstrations to groups of women and to school children. These campaigns are never put on however without the advice of the agricultural agent and a survey of the milk situation.

Clothing. The interest in this work has continued to grow. Many clothing clubs were organized during the year. One agent reports as follows: "One woman said she had never thought about ways of buying or many things in regard to clothing until the matter was discussed last year at the club and she was very much interested in asking help in planning how to remodel a wool dress with a very full skirt. Another said she had not worn high heels since the agent had spoken of the effect on health and the inappropriateness of them."

Child Welfare. Not as much of this work has been done the past year as previously as we had no health specialists at the College. Some of the agents held child welfare meetings during July and August. Some have urged the weighing and measuring of the children by the nurses previous to milk campaigns.

HOUSEHOLD MANAGEMENT.

Home Conveniences. One agent put on a home convenience tour which was a real success. One remodeled house in town was visited where they had several built-in conveniences. All of the other homes visited were in the country. Some had lighting systems, some water systems, and many other conveniences.

Most of the agents who had exhibits at the fairs either showed the model kitchen or desirable home conveniences.

Many talks and demonstrations on labor saving devices have been given. Merchants report it is almost impossible to keep enough of some of the smaller labor savers on hand to meet the demand, since the demonstrations.

Home Account Books. All agents have had extensive calls for the home account books. Not as much follow-up work has been done as was anticipated.

POULTRY.

All agents have done a great deal of culling work and several have

organized poultry clubs in cooperation with the poultry specialists. It is hoped that another woman poultry specialist will be obtained that this work may be continued.

CLUB WORK.

A minor yet an important part of the work of the home demonstration agents has been the girls' club work. They have organized and carried through principally the canning, garment making, and hot lunch clubs. Several trained demonstration teams for the State Fair last fall.

CONFERENCES.

Two splendid conferences were held for the agents this year at which plans were talked over and made for the coming year. Illustrative material was prepared and some real class work done in preparation for their work.

Following is the

Statistical Report County Home Demonstration Agents, July 1, 1919, to June 30, 1920.

County.	Lectures.		Demonstrations.		Home Visits.
	No.	Attendance.	No.	Attendance.	
Allegan.....	56	1,372	33	582	4
Chippewa.....	34	701	28	232	26
Dickinson.....	106	3,474	88	1,130	74
Gogebie.....	52	1,825	48	774	59
Houghton.....	69	2,374	61	2,442	134
Kalamazoo.....	56	4,533	31	501	2
Manistee.....	71	3,208	44	473	89
Oakland.....	21	1,227	.....	.....	21
Ottawa.....	43	2,010	28	528	19
St. Clair.....	67	1,020	39	1,714	30
Schoolcraft.....	38	571	37	652	17
Wayne.....	69	2,549	44	477	62
Berrien.....	22	323	12	250	31
Cass.....	5	285	4	54	13

A REPORT OF BOYS' AND GIRLS' CLUB WORK.

For Fiscal Year Ending June 30, 1920.

Director R. J. Baldwin, East Lansing, Michigan.

Dear Sir: I have the honor of submitting to you herewith the report for the Department of Boys and Girls' Club Work for the fiscal year ending June 30, 1920.

ORGANIZATION.

The progress in organization has been through the channels already in operation in this department. The administration of this organization has been in the hands of state, county and local club leaders, together with the advisory boards of the several local clubs. Emphasis has been placed upon the formation or organization of local clubs through which the agricultural, educational and social program of the Division of Extension might be carried on.

The policy of increasing the number of full time, twelve months, county club leaders, has been adopted. These year around club leaders are placed in the several counties through the cooperation of the county farm bureaus. The program of work of the county club leaders is such as to harmonize with the program of work of the farm bureau in that county.

Cooperating in the promotion of this organization are the many departments of the Division of Extension together with many outside groups. Among the last named might be mentioned: The Michigan Crop Improvement Association, The State Bankers' Association, The Michigan Potato Growers' Association, The Michigan State Fair, The Department of Public Instruction, The Michigan State Federation of Women's Clubs, Boards of Supervisors in the several counties, Boards of Education in the several counties, Upper Peninsula Development Bureau, The Michigan State Teachers' Association, together with a large number of commercial concerns.

LEADERSHIP.

The staff of paid club leaders now consists of the following persons:

R. A. Turner, State Club Leader.....	East Lansing
A. G. Kettunen, Assist. State Club Leader.....	Marquette
Barbara Van Heulen, Assist. State Club Leader.....	Marquette
Elda I. Robb, Assist. State Club Leader.....	East Lansing
Margaret G. Hatty, Asst. State Club Leader.....	East Lansing
W. A. Anderson, Asst. State Club Leader.....	East Lansing

COUNTY CLUB LEADERS.

G. O. Stewart, Wayne.....	Dearborn
E. F. Lyons, Washtenaw.....	Ann Arbor
B. O. Hagerman, Houghton.....	Houghton

A. L. Strang, Saginaw.....	Saginaw, W. S.
Ann R. Banks, Cheboygan.....	Cheboygan
K. B. Smith, Genesee.....	Flint
R. W. Tenny, Eaton.....	Charlotte
Marjorie E. Place, Lenawee.....	Adrian
Viva Osborn, Branch.....	Coldwater
Alba Stenson, Baraga.....	L'Anse
Mrs. A. N. Varney, Hillsdale.....	Litchfield
Marian L. Wheeler, Jackson.....	Jackson
W. D. Hills, Iron.....	Crystal Falls
O. C. Goss, Van Buren.....	Bangor
T. R. Shane, Chippewa.....	McCarron
Y. G. T. Rehner, Alger.....	Eben Junction
H. F. Herrod, Calhoun.....	Battle Creek
K. P. Silberg, Gogebie.....	Ironwood
Evelyn Pepper, Osceola.....	LeRoy
Levi Pfenning, Gladwin.....	Gladwin
Stephana Butler, Macomb.....	Washington
Mrs. M. R. Cameron, Luce.....	Newberry
Carrie Moore, Schoolcraft.....	Manistique

COLLABORATORS.

R. N. Kebler, Menominee.....	Menominee
Grace Watson, Kent.....	Grand Rapids
M. B. Melican, Delta.....	Escanaba
T. E. Ousterhout, Iosco.....	Tawas City
L. E. Baird, Lapeer.....	Lapeer
Etta Paulson, Muskegon.....	Holton
G. D. Gilbert, Oceana.....	Hart
Floyd Ferguson, Isabella.....	Mount Pleasant
A. F. Speltz, Charlevoix.....	East Jordan
Francis Ode, Mason.....	Scottville

In addition to these paid leaders there were 1071 local volunteer club leaders in the various counties throughout the State. There were 55 county agricultural agents and county home demonstration agents who assisted in supervising clubs. Nine of the above named county club leaders are employed for the full year of twelve months. The remainder are employed for a period less than one full year.

RESIGNATIONS.

The following resignations went into effect during the year:

Miss Anna B. Cowles, State Club Leader for Girls.

Miss Ruth Wheaton, County Club Leader, Cheboygan County.

Mr. Frank A. Davis, County Club Leader, Kent County.

Miss Theresa McDonald, County Club Leader, Saginaw County.

APPOINTMENTS.

Miss Barbara Van Heulen was appointed to succeed Miss Anna B. Cowles, with the title of Assistant State Club Leader.

The following appointments became effective during the year:

Miss Ann R. Banks, County Club Leader, Cheboygan County.

Mr. A. L. Strang, County Club Leader, Saginaw County.

Miss Marjorie E. Place, County Club Leader, Lenawee County.

Mr. Levi Pfenning, County Club Leader, Gladwin County.

Mr. Ralph Tenny, County Club Leader, Eaton County.

PROJECTS.

Clubs have been organized in the following projects:

Summer Projects.		Winter Projects.
Crop	Stock	
Corn	Pig	Handicraft
Bean	Calf	Garment Making
Potato	Sheep	School Lunch
	Poultry	
Gardening		
Canning		
Cooking		

Some of these, such as stock projects, have developed into year around projects.

TRAINING SCHOOLS FOR CLUB LEADERS.

State and county training schools have been held for the purpose of developing club leaders. Three state wide training schools have been conducted at Detroit and East Lansing. Twelve county training schools have been held in the various counties. Through an arrangement with the Department of Public Instruction, a course in Club Leadership was presented in 28 of the County Normal Training Classes. Two hundred sixty-two prospective club leaders received training in Club Leadership in this way.

STATE WIDE CLUB EXHIBIT.

The State-wide exhibit for corn, bean, poultry and potato clubs was held at the College in connection with the Annual Farmers' Week, February 2 to 6. At this time State champions were determined and announced. The State-wide exhibit for garment-making clubs was held at the College in connection with the Annual Club Week, June 21-25. State champions were determined and announced at that time.

BOYS AND GIRLS' CLUB WEEK.

The second Annual Boys' and Girls' Club Week was held at the College June 21 to 25. Only those club members who had won state or county championships in their various projects were eligible to attend. One hundred four club champions, together with their leaders, representing twenty-five counties, were in attendance during the week. Over

fifty per cent of these champions had their expenses paid by the farm bureaus of the counties which they represented.

SUMMARY OF PROJECT RESULTS.

Project of Club.	Clubs Organized.	Enrollment.	Members Reporting.	Value of Products.
Corn.....	14	124	92	\$6,442 68
Potato.....	43	287	203	15,578 50
Home Garden.....	1,004	12,987	6,826	97,922 15
Canning.....	132	1,297	1,007	17,401 34
Canning Center.....	5	329	274	3,525 45
Poultry.....	20	173	121	5,915 21
Baby Beef.....	9	152	111	15,696 62
Pig.....	55	655	491	24,527 25
Sheep.....	5	31	19	823 00
Garment Making.....	263	1,760	1,148	10,304 60
Handicraft.....	69	718	559	1,897 10
School Lunch.....	78	1,807	1,328	3,391 93
Bean.....	5	31	12	1,487 80
Totals.....	1,702	20,351	12,207	\$204,957 83

SUMMARIES OF PROJECTS BOYS' AND GIRLS' CLUB WORK.

Year Ending June 30, 1920.

LIVE STOCK PROJECTS.

County agents and county club leaders have come to realize that a definite program is essential to the successful carrying on of Livestock Club projects. In view of this, the cooperation of the Extension Specialist in Dairying has been secured, and an attempt is being made to establish a definite program for the Calf Club project. The Club department has also the assistance of the Animal Husbandry department of the College in the promotion of Pig and Beef Calf Clubs.

Boys and girls having pure-bred animals do not wish to sell but prefer to keep their animals for breeding purposes. Thus the sow and litter projects are attracting wide-spread attention. Many clubs will be in a position to offer pigs for sale this spring to newly organized clubs. During this past year, a larger number of pigs were raised by Michigan club members than ever before.

A livestock judging contest was held at the Michigan State Fair. The State was divided into five sections, each section sending one team to the Fair. A team consisted of three members representing any stand-

and livestock club, the district team being selected by county competitive demonstrations within each section.

The team winning the state championship in livestock judging at the Michigan State Fair was sent to the International Livestock Exposition at Chicago, to compete for Grand Championship honors in the Non-Collegiate Livestock Judging Contest.

The boy having the highest grade in judging dairy cattle represented the State of Michigan in the Junior Dairy Judging Contest, at the National Dairy Show.

W. A. Anderson.

FARM CROP PROJECTS.

Progress in the Farm Crops projects was made along the lines now being followed. Clubs which chose corn, beans or potatoes as their crop, were organized throughout the State.

The Farm Crops department at the College assisted in many ways in furthering this phase of club work. The Michigan Potato Growers' Exchange and The Michigan Bean Jobbers' Association presented a large loving cup to be given annually to the boy or girl winning the State Potato or Bean Club championship.

The annual state-wide exhibit of all crop clubs was held at the College during Farmers' Week, in connection with the annual show of the Michigan Crop Improvement Association.

W. A. Anderson.

HANDICRAFT PROJECT.

The Handicraft project was placed on a sound basis during 1917 and 1918 by Mr. C. A. Spaulding, Assistant State Club Leader, who was in charge of the work at that time. During the year 1919 and 1920, a most satisfactory growth in this work was made. Some twenty-seven new exercises were prepared as a supplement to the regular handicraft bulletin, No. 11, which was prepared by Mr. Spaulding. The new exercises consisted of articles which would be of use in the home and around the farm.

The members of the State staff were influential in presenting the project in different counties and helping the people who were interested, organize the work and conduct follow-up meetings. The aim was to have the State staff assist at the time the work was started, at one follow-up meeting later in the year, and to judge the exhibits at the end of the season. This program was adhered to and was carried out quite successfully.

Each club member, in addition to making the required articles, wrote a story and report and made an exhibit. Practically all of the clubs exhibited some of their articles at the different county fairs, and premiums were offered by the different fair associations.

Montgomery Ward & Company, through the courtesy of Mr. Schott, of the Publicity department, was again influential in helping to tide across a successful program in connection with this project. They offered ten handsome tool chests for the ten best clubs in the State. In addition to this, a large championship tool chest went to the boy who did the best work in the State. Five of the tool chests went to the Up-

per Peninsula Clubs and five went to clubs in the Lower Peninsula. The State championship tool chest was won by Archie Newberg, of the Grand Marais, Alger county.

Another feature was the demonstrations that were conducted at different meetings, county fairs, state fairs and the like. This year the Michigan State Fair paid the expenses of five teams to Detroit for the purpose of demonstrating the work of the Handicraft Clubs. The State was divided into five districts, each district being represented by a team. The prizes awarded at the State Fair were: First prize, a large silver loving cup; second prize, five dollars in War Savings Stamps for each member of the team; third prize, three dollars in Thrift Stamps to each member of the team. Holton team won first prize, Quinnesec, second prize and Saginaw, third prize.

A. G. Kettunen.

POULTRY PROJECT.

Progress in the Poultry Club project was along the lines already followed in poultry club work. In cooperation with Mr. E. C. Foreman, Extension Specialist in Poultry, the program of work for this past year was outlined.

The project was in two parts, and the club member was given the choice of following either of these parts. In the hatching and brooding project the club member began his work with three settings of fifteen eggs each, cared for the hatching and brooding, and for the young chicks through their first growing season. Returns came from the sale of the birds produced. In many instances these birds were retained to be used as foundation stock for farm flocks.

In the Egg and Meat Production project, the club member started with mature birds, and returns were had from the sale of eggs or meat. The project report blank was revised during the year.

The Michigan State Fair cooperated with the department in providing for poultry demonstrations at the time of the Fair. The State was divided into five districts, each district being represented by a demonstration team. These teams were chosen by competitive demonstrations in their respective clubs, counties and districts. Expenses to and from the State Fair, together with suitable prizes, were provided by the Fair management.

In certain sections surrounding our larger cities, the poultry project is one of the most called for of the various club projects. County agents, county club leaders, as well as home demonstration agents, are coming to recognize the place of the Poultry Club work in the farm bureau and unite in furthering this work.

R. A. Turner.

GARDENING PROJECT.

At first thought it was to be expected that the Gardening project would not be as well received this year as last, owing to the fact that many boys and girls raised gardens from the patriotic motive largely. While the total enrollment in the gardening club project is smaller than last year, yet many cities reported the largest enrollment ever.

It is encouraging to note that those boys and girls who continued their gardening club work, did so with no less zeal and interest than

was noted through the war period. Both home and school gardens were fostered. The majority of club members maintained home gardens, however.

In seventy-eight of the principal cities of Michigan, gardening was carried on in an organized way, under the boys and girls' club plan. In certain Michigan cities the garden movement has progressed to such a point that the Board of Education now employs garden supervisors during the entire year and gardening has a place in the school curriculum along with that enjoyed by the subject of Nature Study.

An interesting feature of the short courses which were presented at the Michigan Agricultural College during the past winter, was the short course in Gardening. This course was offered for the first time and was attended by county and local club leaders, school and college instructors throughout the State. The course is to be repeated during the coming winter.

R. A. Turner.

CANNING PROJECT.

Although the number enrolled in canning clubs the past summer was not as great as last year, the percentage of "finishers" was greater as was the proportionate amount of work done.

The girl canning the largest amount in the State was Martha Ealy of Osceola county, who has to her credit over 1200 quarts of fruits, vegetables, jams, jellies, meats, pickles, etc. She has one standing order for \$100 worth of canned products each season, the selection of varieties being for her to decide. Another club member, Donna Baird of Manistee county, has canned her products in tin this year and sold them at local markets.

Mother-Daughter Clubs are still being organized and are doing excellent work. The Live Wire Mother-Daughter Club of Hillsdale county has just finished its fourth season's work.

This year jams, jellies, pickles and soup combinations were made part of the requirement for second year girls and meat or fish were added to third year girls. This made the variety of work done greater, although the required amount was not increased.

Demonstration teams played quite a part in the work of the second and third year girls also. Five of the best teams, each representing one of the districts into which Michigan was divided, gave demonstrations at the State Fair. They were chosen by elimination contests in each district.

The number of canning centers did not equal that of last year, due no doubt, to the fact that the war was over and people did not feel the need of conservation of food as they had before. However, those which survived this year will be permanent institutions. In several cities they are part of the garden club work and are under the direction of the Board of Education.

The largest center is under the auspices of women in a suburban rural community who have the interest of the boys and girls at heart, and also having big farms, they see the opportunity this gives them for having their surplus products canned. Two supervisors were engaged in this center, one taking charge of the club work and the other of the canning work.

Elda Robb,

GARMENT MAKING PROJECT.

Results in the garment making project nearly trebled those of the preceding year. We found, also, that the clubs were more stable and doing more genuine club work than they were when the volatile type of members were enrolled. The valuation of the articles made was higher, and would have been greater, had it not been for the fact that many clubs were forced to drop the work, owing to the loss of school time during the influenza quarantines.

Five districts were represented at the Michigan State Fair by drafting demonstration teams. Several county fairs also held demonstration contests for the different groups within the county.

One club has completed three years of work and is now experimenting on a group of lessons in household management, care of the home and home decoration.

Our new bulletin is being compiled and will be ready for distribution February first.

Barbara Van Heulen.

HOT LUNCH PROJECT.

The season of 1919-1920 proved most successful for hot lunch work. More clubs were organized than ever before in the history of club work in Michigan. The gardening and canning clubs find a ready market for their products in the hot lunch club. This project appeals to the teachers particularly because it includes both the boys and girls. They appreciate also the value of the work from the health standpoint. It is a means of solving the noon hour problem in the rural school and establishes a splendid relationship between the teacher and pupils. It has substantial and enthusiastic backing of the county school commissioners as well as the home demonstration agents, the county agent and the county nurse. The hot lunch bulletin No. 12 is being revised and will be ready for distribution by February first. It will include important changes which will make the work more practical as well as making it easier to get in the reports. The hot lunch requirements for each member are as follows:

Each club member is required to be cook and bookkeeper for one week and a housekeeper for one week and to hand in a report and story. When a club is very large such as is the case in most village schools or the members are very young, only one report and story is required. The treasurer sends in the report and the secretary the story.

PLAN OF WORK.

Team	First Week	Second Week
1	Cook and Bookkeeper	Housekeeper
2	Housekeeper	Cook and Bookkeeper
Etc.		

The club is urged to hold regular meetings and to take up the study of the simple food principles and the fundamental rules for cooking.

Follow-up work in the form of demonstrations may be given by local, county or state leaders of club work. These demonstrations are usual

ly on some of the most valuable foods for children. This work may be correlated with the lessons on food which are always given in the rural schools in connection with the work on physiology.

Margaret Huffy.

Respectfully submitted,

R. A. TURNER,

State Club Leader.

East Lansing, Michigan, June 30, 1920.

MICHIGAN STATE AGRICULTURAL SOCIETY
ANNUAL REPORT

and

AUDIT AND EXAMINATION

G. W. DICKINSON, Secretary-Manager

MICHIGAN STATE AGRICULTURAL SOCIETY ANNUAL REPORT AND AUDIT AND EXAMINATION.

G. W. DICKINSON, *Secretary-Manager*

OFFICERS.

John S. Haggerty, President.
W. H. Wallace, Vice-President.
C. S. C. Eisenbrey, Assistant Secretary and Cashier.
Peoples State Bank, Custodian of Funds.
G. W. Dickinson, Secretary-Manager.

DIRECTORS.

Terms expire December, 1919: W. A. Williams, Sandusky; C. F. Gates, Sandusky; Frank Coward, Bronson; G. W. Dickinson, Pontiac; John W. Smith, Port Huron; Alton T. Roberts, Marquette; John Leidlein, Saginaw; Jacob DeGeus, Alicia; W. T. Greenwood, Monroe; E. N. Ball, Hamburg.

Terms expire December, 1920: T. F. Marston, Bay City; A. E. Stevenson, Port Huron; Charles T. Prescott, Tawas City; W. J. Goodspeed, Lansing; George Kelley, North Branch; C. A. Tyler, Detroit; H. H. Halladay, Clinton; H. S. Newton, Hart; F. J. Lessiter, Clarkston; H. W. Norton, Jr., East Lansing.

EX-PRESIDENTS.

John T. Rich, Elba; I. H. Butterfield, Detroit; E. Howland, Pontiac; Eugene Fifield, Bay City; Fred Postal, Detroit; Thomas E. Newton, Detroit; D. D. Aitken, Flint.

OFFICES.

Detroit, Michigan, 502 Bowles Building; Telephone Main 2655.

COMMITTEES.

Business Committee: John S. Haggerty, Detroit; C. F. Gates, Sandusky; W. J. Goodspeed, Lansing.

Finance Committee: D. D. Aitken, Flint; H. S. Newton, Hart; Frank Coward, Bronson.

Speed Committee: Thomas E. Newton, Detroit; Eugene Fifield, Bay City; John Leidlein, Saginaw.

By-Laws Committee: C. F. Gates, Sandusky; A. E. Stevenson, Port Huron; W. T. Greenwood, Monroe.

Premium Committee: T. F. Marston, Bay City; Charles T. Prescott, Tawas City; G. W. Dickinson, Detroit.

Entertainment Committee: W. H. Wallace, Saginaw; W. J. Goodspeed, Lansing; George Kelley, North Branch.

REPORT OF SECRETARY-MANAGER.

Mr. President and Gentlemen of the Executive Committee:

I am pleased to submit herewith my report of the Seventieth Annual Michigan State Fair held August 29th to September 7th, and recommendations for your consideration. I am sure you will all concede that the 1919 Fair was by far the most successful ever held by our Society, and its growth, both financially and in public opinion, during the past seven years has without question been marvelous. It is true the weather conditions this year were ideal from start to finish. It only rained twice during the ten days of the Fair, both times being in the night, which did not interfere with our attendance. With all of our vast throngs of people, there was no record of any accident of a serious nature whatever, a fact largely due to the splendid co-operation and the care taken by the men in charge of the different departments of our Fair. We have received many complimentary letters endorsing the administration this year, and, taking it all in all, the prospects for the 1920 Fair could not be better.

OPENING NIGHT.

At five o'clock p. m., August 29th, the opening day of the Fair, we opened the outside gates to the public, free of charge, and held a community dance on the pavement from the Administration Building to the Grand Stand. Seven bands were used, and it was a grand success in every way. It brought many thousands of people to our Fair the first night who no doubt had never before attended, which fact was evidenced from the attendance in the Grand Stand, which was entirely filled and for which we charged admission. At eight o'clock the Fair was formally opened by Governor Albert E. Sleeper with an address from the Grand Stand, after which a splendid program of free attractions and music was enjoyed, which I am sure had much to do with our continued attendance throughout the Fair.

UNITED STATES GOVERNMENT EXHIBIT.

Our United States Government exhibit, comprised of the combined War, Navy and other Government exhibits except Agriculture, was staged on the upper floor of the Automobile Building. We had to guarantee \$1,000.00 for the expense of same and send a certified check to Washington. It is expected that a portion of this amount will be returned to us. The exhibit that was furnished was very interesting, the men handling it were very courteous and obliging, and I believe it was appreciated.

WILD LIFE EXHIBIT.

The Wild Life Exhibit this year was one of the main attractions at the Fair. It was staged by the Secretary of the Michigan Sportsman instead of by the State Game Commissioner as in 1918. It was conducted very economically and satisfactorily, and drew a large attendance.

I believe that an exhibit of this kind can be staged each year with a few animals and birds of different varieties housed in some kind of a building which need not cost a great amount of money.

STATE PRISON EXHIBIT.

The State Prison exhibit was staged this year on the upper floor of the Automobile Building, using the entire south end of the building, for which we received \$356.00. It was a very interesting exhibit and showed the work of the prison to thousands of visitors. Prison Warden Hulburt was very liberal and certainly understands the staging of an exhibit of this character to get the best out of it.

AUTOMOBILE SHOW.

Our Automobile Show was better patronized this year than it has been for years. The total receipts for space were \$9,397.95, and the space was entirely sold several weeks before the Fair opened. I believe it would be advisable to change the lighting system in this building throughout and refinish and decorate the upper floor and use it for passenger cars on account of the wood floor, which is much more preferable for this class of exhibits than the cement floor, and use the lower floor for trucks, accessories, etc. To decorate and refinish this building properly it would probably cost between \$3,000.00 and \$4,000.00. I think, however, the rate for exhibit space in this building could be increased to fifty cents per square foot, at which price the entire building would bring us about \$20,000.00, and I think it would be a paying investment for us to decorate and refinish the building this year.

RENTAL OF BUILDINGS.

Our buildings were rented last May to the Maxwell Motor Co. for ten months for \$18,580—about \$1,500 less than in 1918, due to the fact that the buildings were not occupied during the months of June and July, 1919.

POLICING OF GROUNDS.

The policing of Grounds was never as well cared for as this year by the Detroit Police Department. A few plain clothes men and Boy Scouts were all we had on the pay roll. Although we had a vast throng of people every day, not one arrest was made during the entire Fair.

DECORATION OF GROUNDS.

The decoration of our grounds this year was a little more elaborate than ever before, the total cost of same being \$1,463.80. It being a victory year, it seemed to be necessary that we provide a little better decoration. I think the beautifying of the grounds at Fair time is a good move, and if necessary we should spend even more in 1920 for this purpose.

PREMIUM LIST AND OFFICIAL PROGRAM.

The advertising in our 1919 Premium List amounted to \$3,895.00 and in our Official Program, \$4,020.00, a total increase over last year of \$1,390.00.

GLEANER TEMPLE.

The Gleaner Temple, constructed on our grounds last year by the Ancient Order of Gleaners, proved to be a very attractive place. They had representatives on hand every day of the Fair and provided a splendid daily program for the entertainment of their members as well as patrons of the Fair. It was a wise move on our part in allowing the Gleaners to construct this building, as they are much interested and give us more cooperation than ever before.

HORSE RACES.

We had six days' horse racing this year, both the harness and saddle classes. Our harness races were conducted under the Michigan Short Ship Circuit on the half-mile track. The amount paid in prizes for all horse races was \$7,690.00. No pools were permitted to be sold at our 1919 Fair by order of the Mayor, which was a loss to our Association of about \$6,000.00 over last year for the sale of the privilege.

AUTO RACES.

We held automobile races three days, including Decoration Day. Because of the baseball team being at home in Detroit at that time, we were not very well patronized. However, the automobile races on Saturday and Sunday, the opening of the Fair, were a grand success, and I am satisfied they drew many thousands of people, as the grand stand was full to overflowing both days.

FREE RETURN OF EXHIBITS AND REDUCED PASSENGER RATES TO FAIRS.

The free return of exhibits in 1918 was unsatisfactory, as it did not provide for an exhibitor making a circuit of fairs; therefore it became necessary for me to go to Washington, being appointed chairman of the committee from the National Association to take up this matter with the United States Railroad Administration; also that of reduced passenger rates. We finally secured a very satisfactory arrangement providing that when an exhibitor attended a single fair and returned home he was charged only on the going trip; and when he attended a circuit of fairs he was charged one-half rate between all points, returning from the last place of exhibit home at one-half rate. This freight rate applied to all fairs and to any point in the United States, while in 1918 it was confined to intra-state shipments only.

A one and one-half rate on passenger fares was made for the 1919 fairs throughout the United States, making the going movement the day before the fair opened and good returning until the next day after the fair closed, which was a very satisfactory arrangement. The United States Railroad Administration must have been convinced that the fairs are of great benefit, to make such a reduced rate in these times.

EXEMPTION FROM WAR TAX.
THE PRICES

In February last, the Committee on Taxation changed their ruling somewhat on that question. While no tax is made on admissions to the grounds or grand stand, a tax is made on admissions to all shows. As a member of the Committee of the National Association on Federal Legislation, I have been trying to get the old ruling restored, but up to this time I have not met with success. In 1918, if an automobile race meet was held on our grounds other than at Fair time, there was no tax collected. Under the present ruling of the Tax Committee we would now be obliged to pay a tax on such meets; also upon all shows upon our grounds during the Fair. This is a matter that will have to be taken up again this year.

APPROPRIATION.

Since our last annual meeting we took up with the Legislature the subject of an increased appropriation for Michigan fairs. We asked for an annual appropriation of \$100,000.00 for the next two years, which amount was cut to \$75,000.00 being 50 per cent more per year than we formerly received. The amount apportioned the Michigan State Fair this year was \$24,000.00—\$8,000.00 more than we received last year. The amount apportioned the other fairs about the state was 60 per cent of the amount paid by them in premiums in 1918. The increase in premiums paid by our Society this year over 1918 was upwards of \$9,000.00, while we received an additional \$8,000.00 over our former appropriation. This was not so largely the result of an increase in premiums, but partially because of the fact that nearly all the classes filled in every department. No doubt the same amount, \$24,000.00, will be apportioned the Michigan State Fair for 1920.

BONDS.

The total bond issue now against our property in \$355,000.00, with only \$255,000.00 outstanding—\$100,000.00 being unsold and on hand. There was paid on May first the amount of bonds falling due on that date, \$10,000.00 with \$15,500.00 interest for the year. Our bonds all fall due on May first, 1920, and it will then be necessary to reissue the same.

INSURANCE.

The insurance on our buildings has been renewed, and we are now carrying \$181,500, at a cost \$2,611.78 being 4 per cent less than last year on account of the war tax being removed.

STREET CAR FARE.

With reference to the D. U. R. charging two fares from the city to the Fair Grounds; during the past year I have taken this matter up with the Mayor and Common Council and impressed upon them the importance of the adjustment of matters with the D. U. R. to make a single fare rate good to the Fair Grounds. I have also taken this matter up along the same line with the Assistant General Manager of the D. U. R., Mr. Burdick, with whom I have an intimate acquaintance. He assured me if it were possible to make arrangements with the city so they

would have enough money to pay for operating expenses and a little to the good, they would be only *Preggi* to make the single fare good to our grounds. I am in hopes it will not be long before this can be worked out. I am getting up a petition now which will be signed by all the property owners north, south and east, and in the vicinity of the Fair grounds, complaining of the unjust discrimination in street car service and fares. This petition will be signed by about 1,000 property owners, and should be of some assistance to us in securing the single fare rate.

PERMANENT IMPROVEMENTS DURING THE YEAR.

4,200 square feet of new sidewalk was constructed during the year at a cost of \$852.00.

New eave troughs were installed on the inner roofs of the Poultry Building, also drainage to same.

We purchased a one-horse lawn mower at a cost of \$300.00 which will do the work of six men; also a new Ford truck at a cost of \$800.00.

On account of the lack of water on our grounds because of the inadequate supply on Woodward Avenue, which has only an 8-inch pipe line, we connected up with the 18-inch water main coming in from the east from John R. Street, coupling our two mains together at the intersection of Fifield Street and Ransom Boulevard, at a cost of \$3,401.90. For the handling of our centrifugal pump, as a booster to the water on our grounds we purchased a new 25-horsepower motor at a cost of \$779.89. With this new addition to our mains we had no difficulty whatever this year so far as our water supply was concerned.

REPAIRS TO BUILDINGS AND EQUIPMENT.

Each year our wooden buildings, which are many, require a great amount of repairs. Many of them now need repainting. We are continually going over the roofs to make them last as long as possible.

It will be necessary to rebuild a number of the stalls in the horse barns before another year, and in doing so we will change a large number of the single stalls over into box stalls. We find that the box stall is in greater demand than the open single stall, and the cost of a single stall to the exhibitor is \$1.00, while the box stall is \$3.00. It requires two single stalls to make one box stall; therefore it is to the advantage of the Fair to have more box stalls.

Considerable repairing will be necessary on the Administration Building next year, as the foundation under the porches is decaying. Some of the upper porches are also badly in need of repair. Take it all in all, the repairs for next year will in my judgment exceed the repairs of any other year.

I desire to call your attention to the present needs of the Society in the proper equipment of our plant, that the Fair may obtain the maximum results in the fulfillment of the purpose for which it was created.

We need a fireproof live stock barn with enclosed show ring. This building could be constructed to care for the cattle, sheep and swine exhibits, and the judging ring could be sufficiently large to take care of the horses as well.

We also need to enlarge our Grand Stand. This, in my judgment, can be done most economically by narrowing up our race track twenty

feet and extending our seats from the present box seats to the new line of the Grand Stand enclosure, which would be in the neighborhood of fifty feet. Thus the entire length of the Grand Stand constructed of reinforced concrete, would add several thousand seats to the Grand Stand at a very nominal cost.

We also need a building in which to house the State exhibits. In my opinion this building should be constructed by the State, and all State, Government and County exhibits placed therein. There is no reason why our Association should supply the State of Michigan with exhibit space free of charge, and I believe it would be well at the next session of the Legislature to get all of the departments interested and ask the Legislature for at least \$50,000.00 for the construction of such a building. I have had some talk with the manufacturers of Detroit, and from what I can learn it is possible to erect a manufacturers' building, making a five-year contract with a sufficient number of the manufacturers for space therein, the receipts from which, covering the five-year period, would nearly pay for the construction of the building. The exhibit space at the 1919 Fair was sold many weeks before the Fair opened, and we will certainly need more space for 1920.

I feel sure I can say without fear of contradiction that there never was a State Agricultural Exhibition conducted along educational lines offering large sums for premiums, and operating at what may be called popular prices of admission, which has cleared enough in net profits to provide funds for the entire erection and maintenance of its plant; but if we are as prosperous each year for the next five years as we were this year, and I see no reason why we should not be, as the prospects are very bright for the future, we will have made enough during that time to almost duplicate our present plant besides paying the usual ten thousand each year of our bonds.

A new 11-foot sewer is under construction coming from the east and is less than a mile from our grounds. As soon as it reaches us we will be required to connect up with it—a much needed improvement in connection with our plant.

We have been notified by the City Plans Commission that Woodward Avenue will be widened to 100 feet, which would take 17 feet off the front of our property. This will in all probability disturb our new entrances and we should endeavor so far as possible to require the city to pay the damages. This same Commission was planning on an outer boulevard, taking about 60 feet off the south side of our grounds. We have had conferences on this subject and protested, claiming it was not necessary and was unreasonable. Their present plan now is to take a strip of land 150 feet off the north end of our property, which would include nearly all of the north end of our race track; then swing south to a point near the center of the subdivision at the northwest corner of our grounds and south of the Eight Mile Road. Action should be taken as to what our position will be in the matter. I would suggest if they acquire the land, about ten acres lying between the proposed new boulevard and our north line facing on Woodward Avenue and turn it over to us, that we consent to the improvement; otherwise we would object to the plan entirely. I have already made this suggestion to the Committee.

DEPARTMENTAL EXHIBITS.

A perusal of the comparative statement will show an increase in all of the Live Stock Departments this year, and in taking up this subject I desire to explain the conditions under which we are laboring, which I am sure must be apparent to most of you.

HORSES.

We have outgrown our exhibit barns and it is necessary for us to do the judging on the street as we have no other place. We had a splendid exhibit this year both in the breeding and show horse classes. The Department was handled in a very scientific manner under the supervision of Mr. Prescott, and many complimentary remarks were made by the horse-loving visitors. The show horse, in my opinion, will become more popular each year, but I fear there will be a decrease in the draft horse classes because of the use of the auto truck.

CATTLE.

We had a splendid exhibit of the beef breeds this year. The two carloads of fat steers made a decided hit and such exhibits should be encouraged. We can rest assured that this division of the Department will be a success while under the supervision of Mr. Lessiter. We had about the usual exhibit of dairy cattle, but double the number of dairy breeds we had on exhibition would, in my opinion, be only a fair showing for Michigan. There are many good herds of dairy cattle in the State which should be encouraged to show, either by added premiums or better conditions, possibly both. The cow test, which was suggested and arranged by Superintendent Norton, proved to be very interesting, and I believe under his direction and with favorable conditions this Department can be placed on a par with the beef breeds.

SHEEP.

I believe we had by far the best exhibit in the Sheep Department ever shown at the Michigan State Fair. The barns were insufficient and it became necessary to put some of the sheep in the Swine Barns. The fine wools especially made a great showing. No complaints, whatever, were received, and nothing but the highest complimentary remarks were heard as to the treatment of our exhibitors and visitors by Superintendent Coward.

SWINE.

In this department we had thirty exhibitors, a larger number than ever before. The show was of the highest quality and the barns were nearly filled. The exhibitors all seemed pleased with the manner in which they were treated, and the efforts put forth by Superintendent Ball in meeting them on their arrival any hour of the day or night made a decided hit, not only in the Swine Department, but in other Live Stock Departments.

POULTRY AND PET STOCK.

This department has proven to be one of the central points of interest on the Grounds under the efficient management of George Kelly as Member in Charge, and Professor Burgess as Superintendent, giving their personal attention to the many little details so necessary to the success of any department. This building has proven to be a wonderful addition to our Fair Grounds and I hope I may live to see all the live stock housed in a like manner.

DOG SHOW.

The Dog Show, held three days on the upper floor of the Poultry Building, made a decided hit at the Fair this year. We made a charge of 25 cents admission and received from this source \$2,333.35. We heard no complaints from the visitors on account of this charge.

The Pet Stock and Pigeons occupied the upper floor of the Poultry Building, the balance of the Fair, and the exhibitors were pleased to have their stay shortened up three days on account of the Dog Show. The change was made in the night time and during the early morning and did not interfere with the visitors. We should continue putting on an annual Dog Show.

FARM PRODUCTS.

Each year this Department seems to grow in popularity. It only goes to show that with experience we become more successful, as is the case with the handling of this department by Mr. Marston. The building was tastefully arranged and decorated. It is true we allowed a few concessions in this building this year; however, they did not interfere in any way, and the money received from such concessioners was sufficient to pay all the expense of the Department outside of the premiums.

FRUITS, PLANTS AND FLOWERS.

Taking everything into consideration, dry weather and a shortage of flowers, the exhibit in this Department was a great credit to those in charge. This, like the Agricultural Department, headed by H. S. Newton, is sure to be better every year. On account of the Fair being held at such an early date we all know it is impossible to get the finest kind of fruit, and when we have a failure in the flowers it is a difficult Department to handle and make a proper showing; therefore, I feel that Mr. Newton is to be congratulated on having such a good exhibit.

MACHINERY.

The machinery and implement show this year was extensive, and Mr. Stevenson deserves great credit for the manner in which it was arranged and displayed. The Machinery Building was filled and many exhibitors who desired space inside were forced to take outside space. As a whole, this exhibit was very creditably and efficiently handled. The tractor show is becoming more important each year and the tractor is a machine in which the farmers are very much interested. We should have more room in which to make tractor demonstrations.

DAIRY, DOMESTIC AND APIARY.

The Dairy and Domestic Department was about on a par with previous years. The space in this building was sold long before the Fair. It was nicely decorated and was one of the central points of interest on the Grounds.

The Apiary exhibit has grown to such an extent that some day we will need an Apiary Building. Mr. Tyrrell, Superintendent of this department, although engaged in other business, is at heart a bee man, and under his management it will not be long before this department will be a source of revenue to the Fair, besides being a very interesting and educational show.

NEEDLEWORK.

The needlework shown on the upper floor of the Woman's Building, was one of the central points of attraction on our Grounds. While the exhibit was not as large as in 1918, it was of a better quality because of the fact that we prohibit the showing of an article which has not been made during the ensuing year. The exhibit was of high quality and very attractive.

HANDICRAFT AND FINE ARTS.

The Department of Fine Arts this year presented an exhibit of surpassing interest. A college course of ten days in "How Artists Work," proved to be a great drawing card. Many visitors were so interested that they attended the lessons nearly every day. It became necessary to move out in the open because the building was too small to take care of the crowds gathered to witness the work. It will be necessary in the near future to enlarge this building to properly house and take care of the exhibit.

EDUCATIONAL.

Our school exhibit, while not as large as in 1918, was by far a better exhibit. It was handled in a very scientific manner by Superintendent Cameron and his assistants. We are now preparing an advance premium list for our 1920 school exhibit, and I feel certain it will surpass any previous year.

BOYS AND GIRLS AT THE FAIR.

The Boys' Livestock Judging Contest, Girls' Canning and Cooking Demonstration Clubs, Girls' Milking Contest, and Boys' and Girls' Manual Training Contests were exceedingly interesting, coming as they did from so many different localities, and although somewhat expensive is great advertising for the Fair throughout the entire State.

BETTER BABIES' AND PHYSICAL CULTURE BODY BUILDING CONTESTS.

The Better Babies' Contest was never so well patronized as this year. This contest is a stepping stone to the Physical Culture Body Building Contest, which was also well patronized.

G. W. DICKINSON,

Secretary-Manager.

COMPARATIVE STATEMENT.

The following is a comparative statement of the number of entries and premium awards in the different Departments of the 1918 and 1919 Fairs, automobiles and vehicles not included:

Department.	No. of Entries.		Inc. Dec.	Premiums.		Increase. Decrease.
	1918.	1919.		1918.	1919.	
Horses.....	754	647	107	\$6,887 50	\$7,507 00	\$816 50
Speed.....	70	90	20	5,445 00	7,690 00	2,245 00
Cattle.....	748	1,002	254	6,264 40	7,851 50	1,587 10
Sheep.....	998	1,474	476	3,320 40	4,124 40	804 00
Swine.....	632	734	102	2,560 90	3,020 10	459 20
Poultry and Pet Stock.....	1,844	2,780	936	2,483 75	3,412 00	928 25
Farm Products.....	281	220	61	1,421 75	1,968 98	547 23
Fruits, Plants and Flowers.....	2,594	3,135	541	2,818 75	2,661 50	157 25
Dairy, Domestic and Apiary.....	466	444	22	1,109 50	1,142 75	42 25
Needlework.....	1,882	1,532	350	856 00	868 50	12 50
Handicraft and Fine Arts.....	578	414	164	688 50	1,047 00	358 50
Educational:						
School.....	970	889	81	756 25	2,511 28	1,755 03
Physical Culture.....	46	46		366 00	180 00	186 00
Boys' State Fair School.....	83	65	18	2,971 67	1,571 57	1,400 10
Better Babies' Contest.....	92	188	96	159 60	130 00	29 60
Wild Life Exhibit.....				493 30	1,500 00	1,006 70
Total.....	12,038	13,660	1,622	\$38,594 27	\$47,166 58	\$8,572 31

Total Entries 1919.....	13,660	Total Premiums Paid 1919.....	\$47,166 58
Total Entries 1918.....	12,038	Total Premiums Paid 1918.....	\$38,594 27
Increase.....	\$1,622	Increase.....	\$8,572 31
Trophy Cups 1919.....	\$2,280 00	Ribbons 1919.....	\$1,324 36
Trophy Cups 1918.....	1,780 75	Ribbons 1918.....	1,320 08
Increase.....	\$499 25	Increase.....	\$4 32
Increase of Premiums 1919.....			\$8,572 31
Increase of Ribbons 1919.....			4 32
Increase of Cups 1919.....			499 25
Net Increase in Prizes.....			\$9,075 88

AUDIT AND EXAMINATION.

December 2, 1919.

Michigan State Agricultural Society, Detroit, Michigan.

Dear Sirs: We have completed an audit and examination of your books for your fiscal year ending November 30, 1919, and submit herewith our report, together with Exhibits and Schedules as follows:

Exhibit A—Balance Sheet.

“ B—Statement of Revenues and Expenses.

“ C—Comparative Statement of Revenues and Expenses.

“ D—Analysis of Surplus Account.

Schedule 1—Accounts Receivable.

“ 2—Suspensions—Speed Department.

“ 3—Comparative Statement of Plant Accounts.

“ 4—Accounts Payable.

“ 5—Deposits on 1920 Contracts.

“ 6—Miscellaneous Revenue.

“ 7—Administrative Expenses.

“ 7A—Special Expenses.

“ 8—Operating Expenses.

“ 9—Departmental Expenses.

All recorded cash receipts were traced to deposit in the bank.

The Peoples State Bank account was reconciled as at November 30, 1919.

The Accounts Receivable, amounting to \$3,094.23, as shown by Schedule 1, represents only balances due from 1919 operations. The balances on accounts covering previous years' operations were considered uncollectable and charged off.

Schedule 2, detailing Suspensions in Speed Department, amounting to \$130.00, covers those Suspensions reported by the Secretary of your Racing Association for the 1919 racing season. Suspensions amounting to \$7,913.50, which your books showed as being due from previous years, were charged off against Surplus as they were considered uncollectable.

We have mentioned in previous reports the fact that no reserve accounts for depreciation of Plant and Equipment are set up on your books. Therefore, the value of those accounts as shown are accordingly qualified.

Respectfully submitted,

A. W. EHRMAN & CO.

EXHIBIT A.
BALANCE SHEET.

As at November 30, 1919.

ASSETS.

Current:			
Cash on Hand.....	\$67 70		
Peoples State Bank.....	7,207 76		
Pontiac Savings Bank—Certificates of Deposit.....	75,000 00		
			<hr/>
Accounts Receivable (Schedule 1).....	\$3,094 23		\$82,275 46
Suspension (Schedule 2).....	130 00		
			<hr/>
Accrued Interest Receivable on Certificate of Deposits.....			3,224 23
Outside Investments.....	\$50 00		450 00
Liberty Loan Bonds.....	250 00		
			<hr/>
			300 00
Inventories:			
Forage, Paint, Etc.....			1,503 80
Fixed:			
Land (Schedule 3).....	\$309,266 38		
Buildings (Schedule 3).....	424,599 73		
Equipment (Schedule 3).....	51,845 32		
			<hr/>
			785,711 43
Prepaid Insurance.....			2,611 78
			<hr/>
			\$876,076 70

LIABILITIES.

Current:			
Accounts Payable (Schedule 4).....	\$1,233 70		
Accrued Interest on Bonds.....	1,275 00		
			<hr/>
			\$2,508 70
Mortgage Bonds:			
First Mortgage Bonds Authorized and Sold.....	\$200,000 00		
Less: Bonds Redeemed.....	55,000 00		
			<hr/>
Bonds Outstanding.....		\$145,000 00	
Second Mortgage Bonds Authorized.....	\$210,000 00		
Less: Bonds Unsold.....	100,000 00		
			<hr/>
Bonds Outstanding.....		110,000 00	
			<hr/>
			255,000 00
Deferred Revenues:			
Rent in Advance.....	\$14,070 00		
Deposits on 1920 Contracts (Schedule 5).....	6,180 00		
			<hr/>
			20,250 00
Surplus November 30, 1918.....	\$514,114 47		
Less: Adjustment (Exhibit D).....	10,718 30		
			<hr/>
			\$503,396 17
Add: Net Profit from December 1, 1918, to November 30, 1919 (Exhibit B).....	94,921 83		
			<hr/>
			598,318 00
			<hr/>
			\$876,076 70

This Balance Sheet, subject to comments contained in our report of December 2, 1919, and of which it forms a part, in our opinion, substantially reflects the true status of the affairs of the MICHIGAN STATE AGRICULTURAL SOCIETY, as at November 30, 1919.

EXHIBIT B.

STATEMENTS OF REVENUES AND EXPENSES.

December 1, 1918, to November 30, 1919.

REVENUES.

Admissions:		
General Day Admissions.....	\$95,768 17	
General Night Admissions.....	12,784 20	
Grand Stand Night Box Seats.....	1,472 75	
Grand Stand Night Admissions.....	14,664 50	
Exhibitors Tickets.....	1,824 00	
Membership Tickets.....	192 00	
Automobile Tickets.....	6,524 00	
Dog Show Admissions.....	2,333 35	
		\$135,562 97
Auto Races:		
Day Admissions to Grand Stand.....	\$15,197 75	15,197 75
Concessions:		
Agricultural Building.....	1,100 00	
Automobile Building.....	250 00	
Dairy Building.....	650 00	
Grand Stand.....	1,800 00	
Horticultural Building.....	50 00	
Main Building.....	1,150 00	
Midway Revenue.....	9,697 12	
Miscellaneous Concessions.....	37,252 50	
Woman's Building.....	250 00	
		52,199 62
Exhibits:		
Agricultural Building.....	\$25 00	
Automobile Building.....	9,397 95	
Dairy Building.....	1,868 00	
Horticultural Building.....	56 25	
Machinery Building.....	1,378 00	
Machinery Field.....	208 00	
Main Building.....	4,392 70	
Poultry Building.....	50 00	
Woman's Building.....	25 00	
Miscellaneous Exhibitors.....	1,150 00	
Grand Stand Land Show.....	262 00	
		18,902 90
Horse Show:		
Grand Stand Admissions.....	\$4,262 63	
Box Seats.....	1,002 00	
Sundry Revenue.....	31 25	
		5,295 88
Speed Department:		
Entrance Fees.....	\$1,645 00	
Grand Stand Admissions.....	4,262 62	
Score Cards.....	478 33	
Box Seats.....	1,001 50	
Suspension Fees.....	130 00	
		7,517 45
Motorcycle Races:		
Grand Stand Admissions.....	\$1,821 50	
Programs.....	36 25	
		1,857 75
Sundry:		
Electric Current Sales.....	\$1,062 50	
Forage Sales.....	2,623 50	
Interest Earned.....	460 60	
Miscellaneous Revenue (Schedule 6).....	273 66	
Official Program Advertisements.....	3,960 00	
Official Restaurant.....	417 25	
Premium List Advertisements.....	3,895 00	
Rental of Buildings.....	18,497 50	
Rental of Grounds.....	575 00	
Rental of Stables.....	427 00	
tail and Pen Fees.....	3,762 75	
		35,954 76
		\$272,489 08
EXPENSES.		
Administration Expenses (Schedule 7).....	\$51,677 98	
Operating Expenses (Schedule 8).....	58,316 70	
Departmental Expenses (Schedule 19).....	76,629 29	
Interest on Notes.....	127 61	
Interest on Bonds.....	15,550 00	
		202,301 58
Total Operating Profit.....		\$70,187 50
State of Michigan Special Appropriation.....	\$24,000 00	
Sundry Appropriations for Premiums.....	682 33	
Cash Over.....	52 00	
		24,734 33
Net Profit Carried to Surplus.....		\$94,921 83

EXHIBIT C.

COMPARATIVE STATEMENT OF REVENUES AND EXPENSES.
(Condensed)

For the Years 1918 and 1919.

	Year.	Year.	Increase or Decrease.
General Admissions.....	\$79,706 39	\$118,565 12	\$38,858 73
Auto Races.....	11,665 25	15,197 75	3,532 50
Dog Show Admissions.....		2,333 35	2,333 35
Concessions and Exhibits.....	40,358 36	71,102 52	30,744 16
Horse Show.....	8,159 63	5,295 88	2,863 75
Speed Department.....	13,406 13	7,517 45	5,888 68
Grand Stand Night Admissions.....		14,664 50	14,664 50
Official Program Advertisements.....	2,275 00	3,960 00	1,685 00
Official Restaurant.....	387 00	417 25	30 25
Premium List Advertisements.....	4,250 00	3,895 00	355 00
Rental Buildings.....	15,500 00	18,497 50	2,997 50
Special Appropriation.....	16,019 00	24,682 33	8,663 33
Sundry Items.....	11,073 91	9,237 01	1,836 90
Motorcycle Races.....		1,857 75	1,857 75
	\$202,800 67	\$297,223 41	\$94,422 74
Expenses:			
Administrative:			
Advertising.....	\$20,402 74	\$23,155 13	\$2,752 39
Office Salaries.....	6,177 94	6,931 98	754 04
Officers' Salaries.....	10,000 00	10,000 00	
Officers' and Directors' Expenses.....	1,888 19	1,652 64	235 55
Sundry Items.....	7,829 46	9,938 23	2,108 77
	\$46,298 33	\$51,677 98	\$5,379 65
Operating:			
Attractions.....	\$7,971 43	\$6,475 15	\$1,496 28
Fire Insurance.....	2,333 11	2,699 80	366 69
Fireworks.....	7,760 00	9,000 00	1,200 00
Labor, General.....	15,177 33	11,396 39	3,780 94
Liability Insurance.....	64 00	99 10	35 10
Maintenance of Land, Buildings and Equipment.....	5,260 25	12,413 45	7,213 20
Sundry Items.....	8,815 85	16,232 81	7,416 96
	\$47,261 97	\$58,316 70	\$11,054 73
Departmental:			
Auto Races—Prizes and Premiums.....	\$5,000 00	\$6,000 00	\$1,000 00
Auto Races—Miscellaneous Expenses.....	5,071 71	4,109 24	962 47
Better Babies—Prizes and Premiums.....	159 60		159 60
Better Babies—Miscellaneous expenses.....	486 29	569 20	82 91
Boys' State Fair School Expense.....	2,971 67	1,571 57	1,400 10
Cattle—Prizes and Premiums.....	6,264 40	7,831 50	1,567 10
Cattle—Miscellaneous Expense.....	235 00	568 01	333 01
Forward.....	\$20,188 67	\$20,649 52	\$460 85

EXHIBIT C—(Continued).

COMPARATIVE STATEMENT OF REVENUES AND EXPENSES.
(Condensed)

For the Years 1918 and 1919.

	Year.	Year.	Increase or Decrease.
Forwarded.....	\$20,188 67	\$20,649 52	\$460 85
Dairy, Domestic and Apiary:			
Prizes and Premiums.....	265 50	342 75	77 25
Miscellaneous Expenses.....	1,073 18	861 08	212 10
Educational—Prizes and Premiums.....	1,102 10	608 25	493 85
Educational—Miscellaneous Expenses.....	240 88	1,903 03	1,662 15
Farm Products:			
Prizes and Premiums.....	1,421 75	1,968 98	547 23
Miscellaneous Expenses.....	176 87	551 52	374 65
Fine Arts—Prizes and Premiums.....	674 50	1,047 00	372 50
Fine Arts—Miscellaneous Expenses.....	146 00	206 18	60 18
Fruits, Plants and Flowers:			
Prizes and Premiums.....	2,818 75	2,661 50	157 25
Miscellaneous Expense.....	343 58	400 33	56 95
Horses: Prizes and Premiums.....	4,202 50	3,869 50	333 00
Horses: Miscellaneous Expenses.....	287 18	555 83	268 65
Machinery, Department Expenses.....	38 50	201 20	162 70
Main Building Expenses.....		276 15	276 15
Needlework: Prizes and Premiums.....	856 00	868 50	12 50
Needlework: Miscellaneous Expenses.....	293 63	609 00	315 37
Horse Show: Prizes and Premiums.....	2,685 00	3,637 50	952 50
Horse Show: Miscellaneous Expenses.....	3,946 95	3,508 45	38 50
Physical Culture:			
Prizes and Premiums.....	66 00		66 00
Miscellaneous Expenses.....	300 00	180 00	120 00
Poultry, Dog Show and Pet Stock: Prizes and Premiums.....	2,483 75	3,406 00	922 25
Miscellaneous Expenses.....	1,483 94	2,529 39	1,045 45
Sheep: Prizes and Premiums.....	3,320 40	4,124 40	804 00
Sheep: Miscellaneous Expenses.....	190 04	206 00	15 96
Swine: Prizes and Premiums.....	2,560 90	3,020 10	459 20
Swine: Miscellaneous Expenses.....	191 81	216 47	24 66
Motorcycle Races: Prizes.....		275 00	275 00
Motorcycle Races: Miscellaneous Expenses.....		656 62	656 62
Speed: Prizes.....	5,445 00	7,690 00	2,245 00
Speed: Miscellaneous Expenses.....	4,647 03	4,889 55	242 52
Miscellaneous.....	1,780 75	2,280 00	499 25
Automobile Building Expenses.....		516 22	516 22
Wild Life Exhibit.....		1,513 27	1,513 27
	\$63,230 96	\$76,629 29	\$13,398 33
Interest on Bonds.....	15,234 95	15,550 00	315 05
Interest on other items.....	452 78	127 61	325 17
	\$172,478 99	\$202,301 58	\$29,822 59

EXHIBIT D.

ANALYSIS OF SURPLUS ACCOUNT.

December 1, 1918, to November 30, 1919.

1918		Dr.	Cr.
Dec. 1	Balance.....		\$514,114 47
	Add:		
Dec. 2	1918 Needlework Premium Returned.....	\$18 00	
Dec. 5	Refund from P. M. R. R. Account Boys' School.....	48 24	
Dec. 14	Ann Arbor Times—Advance Ticket Sales.....	21 31	
	1919		
Jan. 14	Refund from P. M. R. R. Account Boys' School.....	2 42	
Jan. 24	Refund on U. S. Government Exhibit.....	459 39	
Feb. 28	1917 Checks cancelled.....	119 00	
Mar. 31	1917 Checks cancelled.....	43 00	
Nov. 30	1918 Checks cancelled.....	106 81	818 17
			<hr/>
			\$514,932 64
	Deduct:		
Dec. 1	1918 Premium Needlework.....	\$18 00	
Dec. 7	1918 Premium Dog Show.....	7 00	
Dec. 10	Board of Water Commissioners.....	816 47	
	1919		
Jan. 9	Detroit Ice Machine Co.'s invoice.....	424 00	
Jan. 14	D. J. Healy, services 1918 Fair.....	50 00	
Jan. 15	J. F. Smith, services 1918 Fair.....	122 45	
Jan. 15	Traub Bros., 1918 Trophy Cups.....	7 70	
Jan. 17	R. D. Harrison, services 1918 Fair.....	50 00	
Feb. 8	Maybelle's Mule Show, 1918 Fair.....	25 00	
Feb. 10	D. L. Depew, 1918 Stall and Pen refund.....	9 00	
Mar. 31	Educational Dept., Prizes and Premiums, 1918.....	82 50	
Mar. 31	Horticultural Dept., Prizes and Premiums.....	28 75	
Mar. 31	Poultry Dept., Prizes and Premiums, 1918.....	82 50	
April 30	Refund 1918 Cat Show.....	2 00	
June 30	Fred E. Walker, services 1918 Fair.....	40 00	
June 30	E. T. Cameron, services 1918 Fair.....	7 05	
July 16	Lee Hardware Co.'s 1918 invoices.....	99 55	
Aug. 5	Beardsley & Waltz, services 1918 Fair.....	1 00	
Nov. 30	A. H. Moore's account charged off.....	640 00	
Nov. 30	Charged off bad accounts.....	1,110 00	
Nov. 30	Charged off Speed Dept.—Suspension Fees.....	7,913 50	11,536 47
			<hr/>
			\$503,396 17
	Add:		
	Profits Dec. 1, 1918, to Nov. 30, 1919.....		94,921 83
			<hr/>
Nov. 30	Balance.....		\$598,318 00

STATE BOARD OF AGRICULTURE.

SCHEDULE 1.

ACCOUNTS RECEIVABLE.

November 30, 1919.

Premium List—Advertisers:

Burpee, W. Atlee & Co.	\$60 00
Canadian Government Agency	30 00
Clawson Nursery	33 00
Detroit Creamery Co.	60 00
Edwards & Deutsch Litho. Co.	60 00
Farquhar Furnace Co.	60 00
Healy, J. D.	30 00
Kennedy, Con. T.	4 50
Michigan Business Farming	60 00
Nelson, H. N. Studios	60 00
Pointer, Robert R. & Son	40 00
Security Tire and Rubber Co.	60 00
Tuller Hotel	30 00
United Fairs Booking Co.	60 00

\$647 50

Official Program—Advertisers:

Burpee, W. Atlee & Co.	\$60 00
Detroit & Cleveland Navigation Co.	30 00
Detroit Creamery Co.	60 00
Dodson, Joseph H.	60 00
Farquhar Heating and Ventilating Co.	60 00
Federal Chemical Co.	60 00
Gifford Lumber Co.	30 00
Hinkley Motors Corporation	25 00
Michigan Business Farming	60 00
Nelson, H. N. Studios	60 00
Pontchartrain Hotel	30 00
Siggins Sales Co.	40 00
Tomlinson Watson Co.	40 00
Zurer, Geo. H. Co.	20 00

675 00

Exhibitors:

Ballard & Ballard	\$102 00
Canadian Government	262 00
Department of Health	32 00
Fansler, Orla R. Co.	50 00
Farquhar Furnace Co.	106 00
Ford, J. B. Co.	23 50
Frantz Premier Distributing Co.	78 00
Kelvinator Corporation	31 00
Parrish Bros.	179 60
Red Hot Gas Saver Co.	51 00
Sadowski Music Co.	16 80
Starr Piano Co.	110 20
Webber, Henry, Co.	107 00

1,149 10

Concessioners:

Campbell, C. L.	\$75 00
Detroit Creamery Co.	250 00
Hoagland, G.	75 00
Lanham & Spence	150 00

550 00

Sundry:

Langdon, M.	\$3 00
McLaren, J. D. Co.	64 00
Michigan Agricultural Fair Com., Detroit	39 53
Michigan Agricultural Fair Com., Manistique	3 10
Stroud, Albru.	3 00

112 63

\$3,094 23

SCHEDULE 2.

SUSPENSIONS—SPEED DEPT.

Year

1919	Gage, I. E.	\$20 00
	Sullivan, D. F.	30 00
	Lord, W. J.	20 00
	Hardin, A. E.	60 00
		\$130 00

SCHEDULE 3.
COMPARATIVE STATEMENT OF PLANT ACCOUNTS.
1918 and 1919.

	Book Value Nov. 30, 1918.	Additions Year 1919.	Book Value Nov. 30, 1919.
Land and Improvements:			
Fences.....	\$4,259 63	\$94 50	\$4,354 13
Land.....	208,912 50		208,912 50
Race Track.....	29,631 72		29,631 72
Race Track Drain.....	98 55		98 55
Roads and Drives.....	22,115 19		22,115 19
Shrubs and Trees.....	732 17	45 56	777 73
Sidewalks.....	15,081 86	852 00	15,933 86
Water System and Sewerage.....	22,040 09	3,101 50	25,141 99
Wild Life Park.....	723 84	61 67	788 51
Fox Farm.....		1,512 20	1,512 20
	\$303,595 55	\$5,670 83	\$309,266 38
Buildings:			
Agricultural Building.....	\$15,675 00		\$15,675 00
Arcade Building.....	201 40		201 40
Art Building.....	6,302 48		6,302 48
Auto Building.....	37,541 48	\$511 98	38,086 46
Band Stand.....	2,125 00		2,125 00
Bleachers.....	1,800 00		1,800 00
Cattle Barns.....	13,500 00		13,500 00
Closets.....	15,375 00		15,375 00
Cheek Room.....	2,329 43		2,329 43
Concession Booths.....	2,255 00	275 00	2,530 00
Dairy Building.....	14,911 76		14,911 76
Superintendent's Dwelling.....	4,297 28		4,297 28
Educational Building.....	5,850 00		5,850 00
Entrances.....	4,859 62	77 50	4,937 12
Fire Building.....	1,000 00		1,000 00
Grand Stand.....	57,460 78		57,460 78
Horse Barns.....	29,936 53		29,936 53
Horticultural Building.....	16,034 22		16,034 22
Machinery Building.....	13,774 07		13,774 07
Main Building.....	29,587 18		29,587 18
Michigan Building.....	14,593 96		14,593 96
Poultry Building (New).....	57,293 93	1,213 84	58,507 77
Poultry Building.....	3,150 00		3,150 00
School Building.....	5,394 25	93 10	5,487 35
Sheep Barns.....	8,505 00		8,505 00
Speed Barns.....	26,250 91		26,250 91
Swine Barns.....	9,405 00		9,405 00
Tool House.....	1,800 00		1,800 00
Woman's Building.....	21,186 03		21,186 03
	\$422,395 31	\$2,201 42	\$424,599 73
Equipment:			
Better Babies Equipment.....		\$40 25	\$40 25
Dairy Building Equipment.....	\$22 68		22 68
Electric Plant.....	28,346 01	1,183 37	29,529 41
Fair Ground Furniture.....	284 20		284 20
Engine and Pump.....	1,150 50		1,150 50
Grand Stand Awnings.....	27 00		27 00
Horses, Wagons and Autos.....	1,378 50	650 00	2,028 50
Incinerator.....	12 83		12 83
Lawn Seats.....	2,311 09		2,311 09
Mattresses and Cots.....	288 00	95 75	383 75
Needlework Equipment.....	30 00		30 00
Night Horse Show Equipment.....	115 00	100 00	215 00
Office Furniture and Fixtures.....	2,100 26	1,922 39	3,122 65
Official Restaurant Equipment.....	225 92		225 92
Poultry Coops and Equipment.....	2,550 05		2,550 05
Race Track Tarpanlin.....	1,200 00		1,200 00
School Building Equipment.....	32 37		32 37
Signal Flags.....	12 50		12 50
Tools and Equipment.....	2,878 01	378 00	3,256 01
Turnstiles.....	3,150 73	816 08	4,266 81
Grand Stand Entertainment Equipment.....	843 80		843 80
	\$47,259 48	\$4,585 84	\$51,845 32
Recapitulation:			
Land and Improvements.....	\$303,595 55	\$5,670 83	\$309,266 38
Buildings.....	422,395 31	2,204 12	424,599 73
Equipment.....	47,259 48	4,585 84	51,845 32
	\$773,250 34	\$12,461 09	\$785,711 43

SCHEDULE 4.
ACCOUNTS PAYABLE.
November 30, 1919.

Arco Company, The.....	\$252 00
Detroit Legal News Co.....	22 50
Ehrman, A. W. & Co.....	50 00
Gregory, Mayer & Thom Co.....	767 60
Jewish Chronicle.....	50 40
Lapeer County Press.....	16 80
Lignian, John (Oliver Optic).....	14 40
Northwestern Michigan Development Bureau.....	60 00
	<hr/>
	\$1,233 70

SCHEDULE 5.
DEPOSITS ON 1920 CONTRACTS.

Bear & Brown.....	\$1,430 00
Fair and Carnival Supply Co.....	625 00
Hock, Edward A.....	825 00
Rothstein, Charles A.....	2,500 00
St. Amour, Arthur.....	200 00
Sulaiman, M.....	50 00
Wendal, Otto.....	400 00
Wolfson, Alvin.....	150 00
	<hr/>
	\$6,180 00

SCHEDULE 6.
MISCELLANEOUS REVENUE.
Dec. 1, 1918, to Nov. 30, 1919.

Dividends from F. M. C. A.....	\$50 00
Dog Show Program Advertisements.....	60 00
Four Team Passes.....	40 00
Sale of Dog Show Programs.....	36 75
Nursery Receipts.....	86 00
Sundry Items.....	91
	<hr/>
	\$273 66

SCHEDULE 7.
ADMINISTRATIVE EXPENSES.
Dec. 1, 1918, to Nov. 30, 1919.

Advertising—Billboard, Posters, etc.....	\$5,217 97
Advertising—Miscellaneous.....	2,659 90
Advertising—Newspapers.....	7,074 11
Advertising—Official Program Expenses.....	2,799 46
Advertising—Premium List Expenses.....	2,937 85
Advertising—Publicity Agent's Fees.....	1,019 84
Advertising—Street Car.....	1,446 00
Bookkeeping and Auditing.....	920 00
Commission on Sale of Bonds.....	524 62
Memberships.....	354 87
Office Rent.....	1,245 00
Office Salaries.....	6,931 98
Office Supplies and Expenses.....	4,439 88
Officers' Salaries.....	10,000 00
Officers' and Directors' Expenses.....	1,652 64
Postage.....	993 03
Special Expense.....	697 85
Telephone and Telegraph.....	762 98
	<hr/>
	\$51,677 98

SCHEDULE 7-A.
SPECIAL EXPENSES.

Dec. 1, 1918, to Nov. 30, 1919.

Reception Association of Fairs.....	\$195 00
Premium on Surety Bonds.....	15 00
Testing Milk Samples.....	100 00
Special Prize—Detroit Kennel Dog Show.....	25 00
Bond Expense (Union Trust Co.).....	60 25
Income Tax on Coupons (Union Trust Co.).....	102 60
Flowers for Mrs. Sloan's Funeral.....	16 00
Luncheon for Members of Rotary Club during the Fair.....	119 00
Refund to an old soldier whose pocket was picked.....	15 00
Donation to Detroit Patriotic Fund.....	50 00
	<hr/>
	\$897 85

SCHEDULE 8.
OPERATING EXPENSES.

Dec. 1, 1918, to Nov. 30, 1919.

Attractions.....	\$6,475 15
Auto Expense.....	1,292 63
Decorations.....	1,463 80
Fire Insurance.....	2,699 80
Fire Protection.....	75 50
Fireworks.....	9,000 00
Forage.....	2,707 87
Freight, Express and Cartage.....	233 04
Flower Beds, care of.....	257 94
Labor—General.....	11,396 39
Liability Insurance.....	99 10
Light and Fuel.....	1,443 15
Maintenance of Grounds.....	2,140 53
Maintenance of Land, Buildings and Equipment.....	6,377 46
Miscellaneous Operating Expenses.....	32 67
Official Restaurant.....	1,072 52
Police Protection.....	250 00
Repairs to Buildings and Improvements.....	52 54
Repairs to Electric Plant.....	3,842 92
Ribbons, Badges and Buttons.....	1,324 36
Supplies for Grounds.....	3,977 52
Tents and Awnings, Rental of.....	796 05
U. S. Government Exhibit.....	1,130 68
Water Rates.....	175 08
	<hr/>
	\$58,316 70

SCHEDULE 9.
DEPARTMENTAL EXPENSES.

Dec. 1, 1918, to Nov. 30, 1919.

Auto Races:		
Entertainment.....	\$2,733 81	
Grand Stand Labor.....	420 00	
Miscellaneous Expenses.....	6,145 00	
Decoration Day Races.....	810 43	
	<hr/>	\$10,109 24
Auto Building Expense.....		516 22
Better Babies:		
Judging.....	\$110 00	
Miscellaneous Expenses.....	159 20	
	<hr/>	569 20
Boys' State Fair School Expenses.....		1,571 57
Cattle Department:		
Prizes and Premiums.....	\$7,831 50	
Judging.....	442 51	
Miscellaneous Expenses.....	125 50	
	<hr/>	8,399 51
Dairy, Domestic and Apiary:		
Prizes and Premiums.....	\$342 75	
Judging.....	13 42	
Miscellaneous Expenses.....	847 66	
	<hr/>	1,203 83
Educational:		
Prizes and Premiums.....	\$608 25	
Judging.....	40 00	
Miscellaneous Expenses.....	1,863 03	
	<hr/>	2,511 28
Farm Products:		
Prizes and Premiums.....	\$1,968 98	
Judging.....	179 54	
Miscellaneous Expenses.....	371 98	
	<hr/>	2,520 50
Handicraft and Fine Arts:		
Prizes and Premiums.....	\$1,047 00	
Judging.....	40 00	
Miscellaneous Expenses.....	166 18	
	<hr/>	1,253 18
Fruits, Plants and Flowers:		
Prizes and Premiums.....	\$2,661 50	
Judging.....	153 65	
Miscellaneous Expenses.....	246 68	
	<hr/>	3,061 83

SCHEDULE 9.—Concluded.

Horses:			
Prizes and Premiums.....	\$3,869	50	
Judging.....	241	58	
Miscellaneous Expenses.....	314	25	
			4,425 33
Horse Show:			
Prizes and Premiums.....	\$3,637	50	
Entertainment.....	2,733	81	
Judging.....	282	80	
Grand Stand Labor.....	420	00	
Miscellaneous Expenses.....	471	84	
			7,545 95
Machinery Department Expenses.....			201 20
Main Building Expenses.....			276 15
Needlework:			
Prizes and Premiums.....	\$868	50	
Judging.....	25	00	
Miscellaneous Expenses.....	584	00	
			1,477 50
Physical Culture:			
Miscellaneous Expenses.....			180 00
Poultry, Dog Show and Pet Stock:			
Prizes and Premiums.....	\$3,406	00	
Judging.....	422	04	
Miscellaneous Expenses.....	2,107	35	
			5,935 39
Sheep:			
Prizes and Premiums.....	\$4,124	40	
Judging.....	206	00	
			4,330 40
Speed:			
Purses.....	\$7,690	00	
Advertising.....	194	38	
Entertainment.....	2,733	81	
Grand Stand Labor.....	420	00	
Judging.....	150	00	
Membership Dues.....	105	00	
Printing.....	103	36	
Secretary's Salary.....	300	00	
Sundry Salaries.....	342	50	
Miscellaneous Expenses.....	540	50	
			12,579 55
Swine:			
Prizes and Premiums.....	\$3,020	10	
Judging.....	192	47	
Miscellaneous Expenses.....	24	00	
			3,236 57
Wild Life Exhibit Miscellaneous Expenses.....			1,513 27
Motorcycle Races:			
Purses.....	\$275	00	
Entertainment.....	511	27	
Grand Stand Labor.....	122	35	
Judging.....	10	00	
Miscellaneous Expenses.....	13	00	
			931 62
Miscellaneous Prizes:			
Trophy Cups.....			2,280 00
			\$76,629 29

THIRTY-THIRD ANNUAL REPORT
OF THE
EXPERIMENT STATION
OF THE
Michigan Agricultural College
UNDER THE HATCH AND ADAMS ACTS
FOR THE
YEAR ENDING JUNE 30, 1920

For members and organization of the State Board of Agriculture in charge of the Station and list of officers, see pages 5 and 13 of this volume.

REPORT OF SECRETARY AND TREASURER

The following show the receipts and disbursements of the Experiment Station for the year ending June 30, 1920.

SCHEDULE K-1

	Dr.	Cr.
July 1, 1919. To balance overdrawn.		\$14,113 08
Aug. 16, 1919. received from U. S. Treasury.	\$7,500 00	
Oct. 17, 1919. received from U. S. Treasury.	7,500 00	
Jan. 22, 1920. received from U. S. Treasury.	7,500 00	
April 15, 1920. received from U. S. Treasury.	7,500 00	
June 30, 1920. State Treasurer, 1-5 Mill Fund.	115,624 08	
license fees, commercial fertilizer.	8,241 00	
license fees, commercial feeding stuffs.	17,580 00	
Graham Horticultural Experiment Station.	1,473 43	
Upper Peninsula Experiment Station.	8,623 70	
South Haven Experiment Station.	778 96	
farm and miscellaneous receipts.	1,510 08	
By disbursements as per vouchers filed in the office of the State Auditor General.		169,718 17
Total.	\$183,831 25	\$183,831 25

Fifty thousand regular bulletins No. 285; twenty-five thousand regular bulletins No. 286; twenty-five thousand regular bulletins No. 287; twenty thousand special bulletins No. 98; six thousand special bulletins No. 99; twenty-seven thousand special bulletins No. 100; thirty-five thousand special bulletins No. 101; fifty thousand circular bulletins No. 41; five thousand circular bulletins No. 42; twenty thousand circular bulletins No. 43; four thousand five hundred technical bulletins No. 45; four thousand five hundred technical bulletins No. 46; four thousand five hundred technical bulletins No. 47; fifteen thousand technical bulletins No. 48; fifty thousand quarterly bulletins Vol. 2, No. 1; fifty thousand quarterly bulletins Vol. 2, No. 2; fifty thousand quarterly bulletins Vol. 2, No. 3, have been issued by the Experiment station during the fiscal year.

DISBURSEMENTS ON ACCOUNT OF U. S. APPROPRIATIONS.

	Hatch.	Adams.
Salaries:		
Director and other administrative officers.	\$1,000 20	
Scientific staff.	3,560 90	\$799 90
Assistants to scientific staff.	10,424 35	14,200 10
Furniture and Fixtures:		
15 pans.	14 55	

DISBURSEMENTS OF EXPERIMENT STATION MONEYS—OTHER THAN RECEIVED FROM U. S. TREASURER.

Salaries.	\$54,830 74
Labor.	28,509 01
Publications.	10,705 62
Postage and stationery.	1,358 96
Freight and express.	1,131 74
Heat, light, water and power.	412 73
Chemicals and laboratory supplies.	4,298 41
Seeds, plants, and sundry supplies.	7,664 51
Fertilizers.	1,225 84
Feeding stuffs.	7,856 80
Library.	575 32
Tools, machinery, and appliances.	3,577 78
Furniture and fixtures.	1,140 70
Scientific apparatus and specimens.	884 28
Live Stock.	1,206 34
Traveling expenses.	8,443 40
Contingent expenses.	30 89
Buildings and land.	5,856 10
Total.	\$139,718 17

REPORT OF THE DIRECTOR OF THE EXPERIMENT STATION.

To President F. S. Kedzie.

During the year conditions were favorable for the reestablishment of work seriously interfered with during the period of the war. Among the most important developments are included the establishment of extensive field experiments throughout the State in connection with fertility tests and trials of crop varieties. Investigational work in farm mechanics relating to farm building construction and farm power machinery, were set in motion during the year.

Satisfactory progress was made at the Graham Station by way of the establishment of newly planted orchards covering most of the area now available. We are glad to record the purchase of an adjoining tract of land of fifty acres, thus bringing the total area up to 100 acres. Landscape plans have been prepared and some of the necessary buildings are now being built.

In connection with the Upper Peninsula Station at Chatham which already comprised 720 acres, an additional 40 acre tract, lying directly across the road from the original farm, has been purchased. The building construction work which began several years ago was practically completed this year. As soon as statistics are available from the present crop season, it is the plan to issue a special report of investigational work at this station for the past two years.

In view of the fact that nearly all of the college farm is used at one time or another it is very necessary that attention should be given immediately to the improvement of the farm drainage system. At present a single eight inch trunk line drain is required to carry the drainage water off an area of more than 300 acres, which it is unable to do rapidly enough in the spring season. In order to correct these unsatisfactory conditions an additional twelve inch trunk line drain is needed from the forestry nursery to the Grand Trunk railroad.

Detailed statements of the work of the various sections is included elsewhere. The following statement includes the funds disbursed during the year indicating their source:

Hatch Funds	\$15,000 00
Adams Funds	15,000 00
State Funds	137,241 67
Total	\$167,241.67

The State fund included the sums expended at the sub stations during the year, viz.: Upper Peninsula \$31,276.00, Graham Station \$4,237.31 and South Haven \$2,218.00.

The following list includes all bulletins issued by the Station during the year:

Popular:

285—Commercial Feeding Stuffs.

286—Studies in the Cost of Milk Production, No. 2.

287—Fertilizer Analyses.

Special:

98—Vinegar.

99—The Detroit Commission Plan of City Milk Administration.

100—Soy Beans.

101—Oats in Michigan.

102—Dusting and Spraying Experiments in 1918 and 1919.

Circulars:

41—Laws Governing the Protection and Planting of Street Trees.

42—Short Season Hay Crops.

43—Increasing the Production of the Bearing Apple Orchard.

Technical:

45—The Effect of Fertilizer Salts Treatments on the Composition of Soil Extracts.

46—The Use of Solutions of Ammonium Citrate for the Estimation of Reverted Calcium Phosphate.

47—Studies in the Heat Resistant Organisms of Cold Packed Canned Peas.

48—The Lecania of Michigan.

We greatly appreciate the harmonious and vigorous efforts of all station workers during the year, culminating in satisfactory results and progress. We regret to announce the resignation of H. W. Norton, Jr., taking effect May 1st, after several years of valuable service as Live Stock Experimenter and assistant to the Director.

Respectfully submitted,

R. S. Shaw,

Director of the Experiment Station.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE SECTION OF ANIMAL HUSBANDRY.

Director R. S. Shaw, East Lansing, Michigan.

Dear Sir: I have the honor to submit the following report of the experimental work conducted by the Animal Husbandry section during the past year.

Many feeders have been questioning the advisability of placing a large amount of corn in the silo, contending that it was worth more as dry grain. In October, 1919, one silo was filled with normal corn silage, with corn planted for husking purposes and all ears put in the silo. The other silo was filled with stover, all ears being removed before ensiling. One lot of steers was fed from each silo. Aside from the difference in the silage, all other conditions were identical for each lot. The steers fed on normal silage made an average daily gain of 2.09 pounds. The steers fed on stover silage made an average daily gain of 1.58 pounds. While the steers fed on normal silage made somewhat larger gains than the steers fed stover silage, the extra gain made by the former lot of steers was very expensive in terms of corn required to produce it. This

test will be repeated for three successive years before definite conclusions are made.

Three experimental feeding trials with fattening pigs have been concluded this year. The object of this work was to determine the relative efficiency of corn, barley and rye, alone and in combination, using Digester Tankage as a protein supplement, for pork production. All feeds were fed in separate compartments of a self-feeder, the barley and rye being ground in each case. The following table summarizes the results of three trials:

AVERAGES FROM THREE FEEDING TRIALS.

Rations.	Total "pig days" represented.	Average daily gain per pig.	Average feed consumed per lb. gain.					
			Corn.	Rye.	Barley.	Tkge.	Middlings.	Total.
Corn, rye, barley and tankage.	1,087	1 50	2 23	1 83	.46	.35	.....	4 87
Rye and tankage.....	1,087	1 24	.....	4 51	.....	.42	.....	4 93
Barley and tankage.....	1,087	1 31	.....	.....	4 83	.32	.....	5 15
Corn and tankage.....	1,115	1 56	4 27	.....	.....	.50	.....	4 77
Rye, barley and tankage....	1,358	1 19	.....	1 98	2 54	.34	.....	4 86
Barley, middlings, tankage...	1,386	1 17	.....	.....	3 09	.32	1 41	4 82
Rye, middlings and tankage..	1,358	1 16	.....	2 40	.....	.34	1 83	4 57

Yours very respectfully,

GEO. A. BROWN,

Animal Husbandman.

East Lansing, Mich., June 30, 1920.

REPORT OF THE BACTERIOLOGICAL SECTION.

Director R. S. Shaw,

Dear Sir: I believe it is quite proper this year to list the projects which have, according to my understanding, official approval and sanction. From the Adams fund, we receive aid for the following:

- 1a. The effect of disease in the cow on the milk.
- 1b. The keeping qualities of butter.
- 2c. The decomposition of peat.
- 3a. Market milk investigations.
- 3b. Bovine infectious abortion.

Hatch and State funds are used to supplement the Adams fund in our investigations under the above projects and also for the support of necessary tests and laboratory and field work incident and subordinate to the main investigations. In addition we conduct the following investigations under the support of Hatch and State funds.

1. A study of such animal diseases as occur in the State and come to our attention through the State officials or the veterinarians and their clients.

2. Nitrogen-fixing microorganisms.

3. Various fermentations.
 - a. Vinegar.
 - b. Pickles.
 - c. Milk.
 - d. Stock foods and fodders.
4. Dairy sanitation.
5. Rural water supplies.
6. Bee diseases.

Adams project 1a is in charge of Research Assistant Robert Tweed whose appointment dates from June 1st of this year. He will carry on the work begun by Research Associate L. H. Cooledge giving particular attention to bovine infectious abortion for the coming year. Research Associate I. F. Huddleson has carried the responsibility for this project during the past year along with his regular work on project 3b. The investment in our abortion project is so great that it is the part of wisdom to utilize the equipment and experimental animals to the fullest extent consistent with the demands made upon research. Mr. Cooledge contributed notably to the solution of the milk phases of the abortion problem, but much remains to be done and everything already done should be subjected to further investigation.

Project 1b is in charge of Research Associate G. L. A. Ruehle who reports as follows:

My time has been divided among teaching, work of a popular nature, and research work.

The teaching consisted in instruction by lectures, demonstrations, and laboratory exercises for regular and short course students in dairy hygiene.

The work of a popular nature included (a) official inspection of the milk supply of East Lansing, (b) answering letters of inquiry in regard to dairy hygiene, (c) making analyses of dairy products from dairies having various kinds of troubles, as follows:

(1) Diagnosis of a case of garget. A sample of milk received was examined and found to contain large numbers of long chain streptococci and very many body cells. The aid of the Veterinary department was enlisted for advice as to treatment.

(2) Several samples of milk were sent in for analysis as to bacterial content, which was always very high. In every case the attention of the correspondent was called to the uselessness of sending milk through the mail for bacteriological analysis. Only one of these samples yielded data of value. This was a sample of milk from which it was impossible to make good butter. Microscopical examination revealed the fact that it contained very many yeast cells as well as a miscellaneous bacterial flora. The correspondent was advised that the presence of the yeast probably would account for the trouble.

3. A sample of foamy cream was brought in for examination. The cream foamed to such an extent that on removal of the cork the cream ran over the sides of the bottle. The trouble probably was due to the presence of yeasts which were found to be present in enormous numbers and which imparted a yeasty flavor and odor to the product. The farmer thought that the trouble came from some individual cow's udder but individual samples failed to reveal the yeast or the trouble, though the mixed cream was foamy as usual. He was advised to sterilize all of his utensils by thorough boiling.

4. A sample of goat's milk having a peculiar, disagreeable flavor and a distinct metallic after-flavor was brought in recently and is now being studied. This milk came from one goat in a herd. On microscopical examination the milk was found to contain an excessive amount of cellular debris. On plating the few samples the plate count obtained was approximately 5,000,000 per cc. Gelatin plates made of the sample of milk became completely liquefied. Unfortunately, the cultures which were isolated were accidentally destroyed. A second sample obtained a few days later was evidently much fresher since it gave a plate count on agar of only 5,000 per cc. though the cellular debris still persisted as shown by microscopic examination (3,330,000 cells per cc.). This case is still under study, though other work to be described later in this report points to the probability that the metallic after-flavor is due to the liquefying organisms present in the milk.

In addition to the above work of a popular nature, a trip to Saginaw, Michigan, was made at the request of the Extension department, to attend a joint meeting of milk producers, and the Health Department of the city. The object of the meeting was to consider the framing of a new milk ordinance, embodying the alternative of compulsory tuberculin testing of the cattle or the pasteurization of the milk. During the meeting the writer was called upon to give some technical advice upon tuberculin testing and pasteurization.

The research work for the year consisted in two lines of work as follows: (a) A brief study of the titration of culture media done in co-operation with Mr. Fabian. This work, "Titration of Culture Media" is reviewed briefly by Mr. Fabian in another part of this report. (b) Research on the Adams Fund Project 1b entitled, "The Keeping Qualities of Butter." This work has largely resolved itself into a study of the Metallic Flavor in Dairy Products with Special Reference to Butter. This study, while not complete enough for publication at the present time, has been carried far enough to warrant the statement that metallic flavor in butter and other dairy products is not always due to metals but may be produced by microorganisms of the peptonizing group. At least two organisms have produced this flavor in butter and in milk, one isolated originally from buttermilk and one from metallic flavored butter. It is planned to study this question intensively during the present year.

The work which was done on this project by Mr. Chas. W. Brown and Miss Lulu M. Smith during the years 1909 and 1910 has finally been prepared for publication in a paper entitled, "A Bacteriological and Biochemical Study of some Experimental Butters." This paper has been submitted to the Journal of Dairy Science. (Vol. III, pp. 375-405, 1920.)

The following is a brief summary of the paper: Originally this investigation was intended as a study of the effects of cream ripening and of pasteurization upon the keeping qualities of butter. Owing to the fact, however, that considerable time has elapsed since the work was done and in this time some of the methods and ideas of manufacture have undergone some changes, it is thought best to present the results from the point of view expressed in the title.

While the purpose of this investigation was to study the effect of ripening and pasteurization on the keeping quality of the butter, the

effects of other treatments of the butter were also to be observed. These included, (a) washing of the butter with lactic acid, (b) the addition of casein, (c) the addition of fishy butter, and (d) the addition of boric acid.

A single vat of cream was divided into two equal portions, one of which was pasteurized and the other unpasteurized. Each of these portions was further subdivided into two parts, one part being churned without further treatment and the other ripened by the addition of starter. Each of the four divisions of cream was then churned separately. The butter from each churning was then divided into five portions which were subjected to the four further treatments mentioned above, with one of the portions acting as an untreated control. The twenty different butters (about 60 lbs. each) were packed in 30 pound tubs and shipped without delay to a cold storage plant where they remained for the duration of the experiment at about 0° F. At intervals of 9, 48, 164, 275, and 426 days the butters were scored and sampled for bacteriological and chemical determinations.

The following scheme indicates the divisions of the cream and the treatments of the butters:

		Sample Nos.	Treatments
Cream 28.18% fat 53° Acidity	Raw	Part 1 Churned Immediately 53° Acid	1 and 11 Control
			2 and 12 Acidified H ₂ O in 2nd washing
			3 and 13 Casein added
			4 and 14 Fishy butter added
			5 and 15 Boric acid added
		Part 3 (ripened to 60°)	21 and 31 Control
			22 and 32 Acidified H ₂ O in 2nd washing
			23 and 33 Casein added
			24 and 34 Fishy butter added
			25 and 35 Boric acid added
	Pasteurized at 160° C.	Part 2 Churned Immediately	6 and 16 Control
			7 and 17 Acidified H ₂ O in 2nd washing
			8 and 18 Casein added
			9 and 19 Fishy butter added
			10 and 20 Boric acid added
		Part 4 (ripened to 64°)	26 and 36 Control
			27 and 37 Acidified H ₂ O in 2nd washing
			28 and 38 Casein added
			29 and 39 Fishy butter added
			30 and 40 Boric acid added

While the results of this study failed to reveal any striking proofs of the relationship between methods of manufacture and either the score or the development of definite off-flavors, yet certain facts stand out sufficiently well to warrant mention. They are as follows:

The raw cream butters quickly developed the old cream flavor which was later followed by fishy flavor, while the pasteurized (sour) cream butters early developed a metallic flavor. Tallowy flavor developed more frequently in the raw cream butters than in the pasteurized cream butters. Acid flavor developed much more frequently in well ripened pasteurized butters than in raw butters. From this study there is no evidence that either pasteurization or ripening improves the keeping quality of butters made from cream which has already soured.

Relatively higher bacteriological counts were obtained on butters over a year old than are usually obtained in studies of this kind, though there was a fairly rapid dying off in numbers at first.

The lactic acid bacteria appeared on the plates for a longer period than is usually thought possible, though there was a gradual displacement of the lactic acid flora by a more miscellaneous flora, among which the predominant types were a liquefying and a non-liquefying yeast and an *Oidium* species.

Taking the butters as a whole, there was a slow, gradual decrease in the amount of lactose present and a gradual increase in acidity, though the decrease of the one was not proportional to the increase in the other.

The amount of nitrogen in the pasteurized cream butters was about half that of the raw cream butters, but the percentage of nitrogen in soluble form was about the same in each class of butters, though it was very small in either case.

When 12 of the typical butter organisms were inoculated into milk alone and milk containing 3 per cent of salt, it was found that the number of bacteria increased rapidly in both cases but more rapidly when salt was not present. The increase in acidity was very slight in either case and of about the same amount. The action of these organisms upon the nitrogenous compounds of milk without and with the addition of 5 per cent salt was to increase the amount of soluble nitrogen in both cases but more so without than with salt. This amount of salt, however, does not retard the growth and action of these butter organisms as much as might seem possible.

[G. L. A. Ruehle]

Research Associate Zae N. Wyant has continued in charge of Adams project 2c and also she has pursued her studies on vinegar and food fermentations with special reference to silage and to food preservation. The results of the previous year's work are found in part in Special Bulletin 98, "Vinegar" and in Technical Bulletin 47, "Studies in the heat resistant organisms of cold packed canned peas," the latter by Ruth Normington done under the direction of Mrs. Wyant and myself. The following report is made of progress during the past year:

Silage poisoning: Four samples of silage suspected of poisoning stock were sent in for analysis. One of these samples contained an organism morphologically resembling *B. botulinus* but injection of experimental animals gave negative results.

Silage inoculation, steaming and salting studies—Alfalfa silage: Last October cut alfalfa was placed in two silos, two feet in diameter and six feet high, made of three 2 by 2 ft. glazed sewer tile with joints and bottom cemented. The alfalfa was steamed before being packed into silo No. 2, steaming being employed to destroy some organisms and to allow more alfalfa to be packed into the tile. The silage in both was well tramped. To silo No. 1 was added sufficient water to make the fermentation anaerobic. The steaming made the addition of water unnecessary in the second silo. The alfalfa in both silos was covered with melted paraffin. Although the alfalfa in silo No. 1 was tramped until it was six inches below the rim of the tile, the next day the fermentation became so active as to push the paraffin cover one to two inches above the top of the silo. The fermentation was hardly noticeable at

first in the silo containing steamed alfalfa most probably because of the steaming. Both silos in time, however, gave off a most offensive odor, showing that the steaming was not successful in controlling the organisms producing bad odors, contrary to the experience of a farmer who tried this method last year.

At the end of June, however, the fermentation in the unsteamed alfalfa had progressed so far that to a considerable depth no bad odor was evident while in the steamed silage the fermentation had progressed so slowly that bad smelling silage was uncovered two to three inches below the surface. The silage in the last two to three feet in each silo had the odor of hay that has lain on the ground for some time while damp, or, as it was "scored" by another person, like cow manure—not a putrid odor. It was not acceptable to cattle.

Sixteen smaller experimental silos (2,000 cc. glass cylinders) were prepared with results as follows:

Silo No.	Contents.	Organoleptic tests.	
		Appearance and odor when removed.	With cattle.
Ia.....	Alfalfa.....	Greenish color at bottom. Very bad odor.....	} Cows wouldn't touch this.
Ib.....	Alfalfa.....	Color, ditto. Odor not unpleasant.....	
IIa....	Alfalfa steamed.....	Green one-half way up, putrid odor one-half way down one-third pleasant acid hay odor.....	} Ditto.
IIb....	Alfalfa steamed.....	Ditto.....	
IIIa....	Alfalfa + salt.....	Brownish three-fourths way up, pleasant sourish hay odor.....	} One heifer ate handful rest wouldn't touch it.
IIIb....	Alfalfa + salt.....	Color, ditto. Odor more pleasant.....	
IVa....	Alfalfa steamed + salt.....	Greenish brown, pleasant acid hay odor.....	} Very little eaten.
IVb....	Alfalfa steamed + salt.....	Color, ditto. Faint odor of NH_3 at bottom slightly acid hay odor.....	
Va....	Alfalfa inoc.....	Color, ditto. Halfway up rotten.....	} Rotten—not fed.
Vb....	Alfalfa inoc.....	Color, ditto. One-third way up rotten.....	
VIa....	Alfalfa steamed, inoc.....	Brownish green one-third way up, all but last 4 ins. rotten.....	} Several cows ate this lot pretty well.
VIb....	Alfalfa steamed, inoc.....	Color, ditto. Pungent NH_3 odor, all but last 6 ins. rotten.....	
VIIa....	Alfalfa + salt, inoc.....	Olive brown two-thirds way up, not unpleasant hay odor.....	} Three cows ate this lot with apparent relish.
VIIb....	Alfalfa + salt, inoc.....	Color ditto. Odor ditto.....	
VIIIa....	Alfalfa steamed + salt, inoc.....	Greenish brown one-third way up, brown above, rather musty hay odor.....	} Six cows ate this lot with apparent relish.
VIIIb....	Alfalfa steamed + salt, inoc.....	Dark green, very pleasant acid hay odor.....	

Inoculation for the silage was prepared by treating a pailful of good, fresh corn silage with tap water, and using the infusion thus obtained.

Salt was added to the silage in the proportion of 1 lb. of salt to 100 lbs. of cut alfalfa. This addition was made for the purpose of favoring the lactic fermentation as is done in sauerkraut and brine pickle manufacture.

Although the amounts of silage put up in these small experimental silos was not practical from the feeding standpoint, some indication is given of the type of fermentation occurring under the given conditions

and also of the palatability of the different silages. Plans are being made to conduct similar experiments on a somewhat larger scale again this season.

Experiments were also made on inoculating corn silage. Fifteen small experimental silos were filled with freshly chopped corn each silo holding from 250 to 350 lbs. of corn. Different treatments were given the silos as follows:

Silo

No.

- | | | |
|----|---------------------------|--|
| 3 | Chopped corn alone. | |
| 4 | Do. inoc. | |
| 5 | Do. plus salt (1-90) | |
| 6 | Do. plus salt (1-80) plus | $\left\{ \begin{array}{l} \textit{Bact. bulgaricum} \\ \textit{Bact. lactis acidi} \end{array} \right.$ |
| 7 | Do. (no salt) plus | do. |
| 8 | Do. plus salt (1-80) plus | $\left\{ \begin{array}{l} \text{Acid and gas-producing} \\ \text{lactics } p \text{ and } v \text{ isolated} \\ \text{from corn meal} \end{array} \right.$ |
| 9 | Do. (no salt) plus | do. |
| 10 | Do. plus salt (1-80) plus | $\left\{ \begin{array}{l} \textit{Bact. acidi lactici II}, \\ \text{Novy and Hoeppe} \end{array} \right.$ |
| 11 | Do. (no salt) plus | do. |
| 12 | Do. plus salt (1-100) | |
| 13 | Do. plus salt (1-120) | |
| 14 | Do. plus salt (1-80) | |
| 15 | Do. plus salt (1-60) | |
| 16 | Do. plus salt (1-48) | |
| 17 | Do. plus salt (1-40) | |

Silos Nos. 3, 4, and 5 (glazed sewer tile) containing about 360 lbs. of silage were not opened till summer. So far as ordinary organoleptic tests were concerned there was no difference among them, all being good silage and relished equally well by the cattle fed. The top 6 to 8 inches was decayed and had to be removed. Silos Nos. 6 to 17 were galvanized iron cans painted inside with an acid-proof paint. Each was fitted with a removable cover to imitate natural conditions. These were already sunk in the ground, being originally cans used for soil experiments. Silage from silos Nos. 6 to 13 was fed to seven calves in the fall, three to eight weeks after being filled. About one foot in depth had to be discarded because of being moldy (or putrid in a few cases). Neither the addition of the pure cultures used nor of salt seemed to have any influence on the depth at which mold was found. The silage underneath had a normal clean acid odor in all cases, being somewhat more pronounced in silos No. 6 and No. 10. Neither the presence of the salt in the various proportions nor of the cultures used appeared to influence the palatability of the silage to the calves. The salt was not laxative in the amounts fed.

Some bacteriological studies were made of the inoculated silages. An attempt was made to ascertain whether the type of organisms added to the silage still predominated at the time fed and whether they could be recovered. Plates were made on litmus dextrose agar and on acid whey agar, keeping a set of each at 20°, 37° and 45°C. both anaerobically

and aerobically. Bacteria of the *Bact. lactis acidi* type were easily isolated from the plates from silos 6 and 7 but bacteria of the *Bact. bulgaricum* type could not be reisolated. There was evidence of the presence of acid and gas producers in the 37° litmus dextrose plates from silo 9, but in silos 10 and 11 only acid but no gas producers were found on the plates. It is to be regretted that more detailed bacteriological studies could not have been made. The indications are that if bacteriological analyses are made soon enough on inoculated silage that organisms resembling the pure cultures added, can be detected. However, as previously stated, none of the pure cultures employed appeared to have the effect of inhibiting or suppressing mold growth, nor is it logical that such would be the case. The silage fermentation is largely an acid fermentation, the acids formed being mainly lactic and acetic. These common organic acids in the strengths found in silage are easily and readily attacked by molds of many species under aerobic conditions, such as are always found at and near the surface and occasionally in pockets distributed throughout the depths of the silage. It is doubtful whether any bacteria can produce acid of sufficient strength in silage or in other naturally fermenting material to inhibit mold growth. Bacteriological studies of a sufficient number of experiments have not yet been made, however, to determine whether pure cultures used as inocula will eventually control the fermentation or whether the natural microflora of the silage instead will determine the type of fermentation occurring, in spite of the kind and amount of pure culture added. As time permits this phase of silage inoculation will be studied.

The silos 14 to 17 inclusive containing larger proportions of salt were opened this spring. The top silage to the depth of nearly two feet had to be removed before the typical acid odor was apparent. Molds were found in the first foot and then the next portion appeared all right, but the acid odor was lacking. Silage having a salt content of more than 1.80 at first physiced the calf and sheep to which it was fed but this effect was not produced after the first few feedings. These two animals in time refused to eat much of the more heavily salted silage so its feeding was discontinued. Bacteriological studies were made only from silo 14.

Pure cultures of acid-producing bacteria were isolated from some of the silos and their acid production determined in dextrose, sucrose and lactose broths by means of the colorimetric H-ion concentration method in order to determine the most active and strongest acid producers. The organisms having the best qualifications are to be used in further inoculation experiments. The results of the tests are as follows:

Organism.	pH value in sugar broth of pH 7.6.		
	Dextrose.	Sucrose.	Lactose.
S 6 A.	4 6	4 8	4 0
S 6 B.	5 8	...	...
S 6 C.	5 8	6 0	6 0
S 6 D.	7 0	6 4	7 4
S 6 V.	6 6	6 7	7 0
S 6 VI.	4 5	5 9	5 0
S 6 2.	7 2	7 1	7 0
S 6 2 A.	5 8	below 5 8	below 5 8
S 6 2 C.	6 0	5 7	5 7
S 6 2 D.	6 5	...	...
S 6 2 F.	...	...	above 8 0
S 6 2 H.	below 5 8	...	below 5 8
S 6 2 I.	...	7 2	7 5
S 6 2 II.	5 4	5 8	6 8
S 6 2 III.	6 0	4 8	5 8
S 6 2 IV.	4 6	4 8	6 0
S 6 2 V.	4 4	5 1	4 8
S 7 A.	below 5 8	below 5 8	below 5 8
S 7 B.	...	...	5 8
S 7 D.	7 1	7 1	7 1
S 7 E.	7 0	6 0	7 4
S 7 F.	6 1	6 6	7 6
S 7 G.	5 5	5 4	5 2
S 7 J.	6 9	6 6	7 3
S 7 K.	4 4	4 8	5 8
S 7 I.	6 5	...	...
S 7 III.	6 2	6 2	6 6
S 7 V.	5 4	6 0	7 4
S 7 VI.	7 0	7 1	7 9

To compare with the above table, the pH values of the silage from several silos including the respective silos from which the above cultures were isolated is of interest. The pH determinations were made on a 1-10 dilution.

Silo.	pH value.	Indicator.
6.	7.0*	brom thymol blue
6.	5.3	methyl red
7.	4.6	methyl red
8.	5.3	methyl red
9.	6.5	brom thymol blue

*One week after filling the silo. The second determination was made a month after filling. The pH values of silos 7, 8 and 9, were determined after at least a month of ensiling.

Comparing the acidity of the silage and that produced in the sugar broths by various organisms, it is fairly easy to pick out the organisms which may have influenced the pH value of the silage. The most active and general acid producers are being saved for experiments in silage inoculation to be carried out later in the season. [Zae Northrup Wyant.]

OTHER FERMENTATIONS.

Retting of Flax: A very little has been done this spring in attempting to isolate bacteria which will hasten the retting of flax. As Michigan is the first fiber flax state in the Union it seems no more than logical that the microbiological problems involved in the retting of this fiber plant be taken up in earnest at this station.

Vinegar: During the fiscal year 1918-1919 there were numerous requests for analyses of vinegar and for information as to various phases in its manufacture. Many samples of vinegar were received for analysis the quality of the majority of which was very poor. Several articles dealing with home vinegar making and its troubles published in the Quarterly Bulletin served to increase the requests for information and analyses, and very frequently the necessity arose for lengthy explanations of the fundamentals of the vinegar fermentation in order to acquaint the inquirer with the part that certain microbes play in this process. In February, 1920, the vinegar bulletin came from the press and has served quite satisfactorily in answering the frequent questions. This bulletin will be found elsewhere in this report.

Fifty-nine requests for vinegar cultures were received during the past year, 46 of which were for yeast and 48 for vinegar bacteria cultures making 94 cultures in all.

NUMBER OF VINEGAR CULTURES SENT OUT FROM JULY 1, 1919, TO JUNE 30, 1920.

Michigan Counties.				States.	
Alcona.....	4	Lenawee.....	4	Illinois.....	2
Allegan.....	3	Livingston.....	1	Indiana.....	2
Berrien.....	4	Macomb.....	1	Iowa.....	4
Branch.....	2	Manistee.....	2	Maine.....	4
Cass.....	1	Missaukee.....	2	Massachusetts.....	2
Charlevoix.....	2	Oakland.....	1	Mississippi.....	4
Eaton.....	2	Oceana.....	5	New Hampshire.....	2
Genesee.....	2	Osceola.....	3	New York.....	1
Grand Traverse.....	1	St. Clair.....	2	North Dakota.....	1
Ingham.....	5	Shiawassee.....	1	Ohio.....	2
Jackson.....	7	Van Buren.....	2	Pennsylvania.....	1
Kalamazoo.....	1	Washtenaw.....	3	Washington.....	2
Kalkaska.....	2	Wayne.....	2	Wisconsin.....	2
Total cultures for Michigan.....			65	Total for other states.....	29

As a result of one of the articles on vinegar in the Quarterly Bulletin being published in the "American Fruit Grower" requests for pure cultures came in from Illinois, Indiana, Iowa, Maine, Massachusetts, Mississippi, New Hampshire, New York, North Dakota, Ohio, Pennsylvania, Washington, and Wisconsin.

The cultures sent to Mississippi were ordered by a commercial firm for the purpose of making vinegar from sweet potatoes, our cultures being recommended to them by the Mississippi Agricultural College. At least six cultures have been sent out for making honey vinegar. The requests for these cultures come in through the Entomological department. Also last fall a circular letter was sent to each county agent offering gratis a pure culture each of the yeast and vinegar bacteria

for exhibition purposes. The Missaukee and Lenawee county agents only, took advantage of this offer.

Cultures have been sent gratis to the Bacteriological department of the University of Wisconsin, to the Edwards Laboratories, Lansing, to a teacher of biology and botany in a township high school at Nokomis, Illinois, to the American Museum of Natural History, New York City to the Botany department at Washington State College, Pullman, and to the Botany department of New Hampshire College at Durham.

Many times, however, requests were received for cultures but the content of the letter showed that the fermented cider should have been converted naturally into vinegar many months or perhaps years previously and thus the effect from using pure cultures would be doubtful. An analysis of such vinegars was advised before cultures could be recommended.

Thirty-nine samples of vinegar were tested as follows:

Sample No.	Per cent.		Sugar.	Color.	Flavor.	Remarks.	Suggestions.
	Age.	Acetic acid.	Alcohol by wt.				
107	.....	4.4	5.45	++	Fair.....	Unpleasant after-taste.....	O. K. as to acid.
108	1 yr.....	1.5	2.78	+	Good.....	3.62% more acid possible, slightly cloudy...	Inoc. with <i>Bact. aceti</i> and acetate.
109	.....	1.5	4.35	Trace.....	Good.....	Cloudy.....	Inoc. with <i>Bact. aceti</i> and acetate.
110	2 yr.....	0.4	3.63	-	Lt. amber.....	.....	Inoc. with <i>Bact. aceti</i> and acetate.
111	2 yr.....	0.6	1.20	-	Lt. amber.....	.....	Dump contents of bbl.
112	2 yr.....	0.4	3.89	-	Lt. amber.....	.....	Inoc. with <i>Bact. aceti</i> and acetate.
113	2 yr.....	1.2	0.98	Trace.....	Lt. amber.....	.....	Dump contents of bbl.
114	1 yr.....	0.7	2.64	++	Yellow.....	Bitter flat after-taste.....	Add 1 lb. sugar, inoc. with yeast, inoc. with vinegar bact. Bitter taste may disappear.
115	5 yr.....	3.2	2.92	++	Lt. amber.....	Good.....	Inoc. with <i>Bact. aceti</i> and acetate.
116	3 yr.....	1.2	3.47	+-	Lt. amber.....	Good, only weakly acid.....	Inoc. with <i>Bact. aceti</i> and acetate.
117	.....	1.9	3.02	++	Lt. amber.....	Rancid after-taste.....	Inoc. with <i>Bact. aceti</i> and acetate.
118	2 yr.....	3.4	-	++	Deep amber.....	More acid should develop.....	Allow more acid to develop.
119	2 yr.....	4.3	-	+++	Med. amber.....	O. K.....	Salable.
120	1 yr.....	1.0	-	+-	Lt. amber.....	Too little acid.....	Allow acid to develop further.
121	1 yr.....	2.1	-	+	Lt. amber.....	Better than sample 120.....	Allow acid to develop further.
122	1 yr.....	1.0	6.44	-	Lt. amber.....	Clear.....	Acetate and inoculate with <i>Bact. aceti</i> .
123	1 yr.....	0.7	6.12	-	Lt. amber.....	Cloudy.....	Acetate and inoculate with <i>Bact. aceti</i> .
124	1 yr.....	7.6	1.25	++	Lt. amber.....	O. K.....	Rack off into a clean bbl., fill full, bung tightly.
125	1 yr.....	1.0	7.66	+	Med. amber.....	Cider inoc. with pure cultures.....	Keep warm and ventilate.
126	.....	2.5	1.57	Trace.....	Pale yellow.....	Turbid.....	Inoc. with <i>Bact. aceti</i> and acetate.
127	1 yr.....	0.7	2.64	Trace.....	Pale yellow.....	Too little acid.....	{ Add 1 to 2% cane sugar or molasses and yeast culture keep at 60-65° F. until sufficient alcohol forms to make 4% acetic acid.
128	.....	0.6	1.71	++	Pale amber.....	N. G.....	
129	.....	0.7	2.44	++	Pale yellow.....	Turbid.....	Too little alcohol to make market standard vinegar.

130	.....	6.2	—	—	—	O. K.	Can dilute to 4% if desired.
131	.....	0.8	0.96	Amber	.....	O. K.	Inoc. with <i>Bact. aceti.</i>
132	.....	0.9	2.82	Amber	.....	.....	Allow to ferment longer. Will barely make 4% acetic acid.
133	.....	0.6	4.46	Amber	.....	.....	Inoc. with <i>Bact. aceti.</i>
134	.....	0.9	1.08	Lt. amber	.....	Cloudy	Dump out.
135	.....	5.7	—	Lt. amber	.....	O. K.	Salable.
136	.....	5.4	—	Lt. amber	.....	O. K.	Salable.
137	2 yf.	2.3	1.80	Lt. amber	.....	4.75% acid theor. possible	Pasteurize, put in clean bbl. and inoc. with <i>Bact. aceti.</i>
138	2 yf.	2.0	1.85	Lt. amber	.....	4.45% acid theor. possible	Pasteurize, put in clean bbl. and inoc. with <i>Bact. aceti.</i>
139	2 yf.	1.5	1.15	Lt. amber	.....	Wont be salable 3.15% acid theor. possible.	Pasteurize, put in clean bbl. and inoc. with <i>Bact. aceti.</i>
140	2 yf.	0.4	0.76	Lt. amber	.....	Less than 1% acid theor. possible	Dump out.
141	2 yf.	1.5	2.15	Lt. amber	.....	4.3% acid theor. possible	Pasteurize, put in clean bbl. and inoc. with <i>Bact. aceti.</i>
142	2 yf.	2.5	5.07	Lt. amber	.....	Fairly clear	
143	2 yf.	1.5	5.74	Lt. amber	.....	Rather turbid	Inoc. with <i>Bact. aceti.</i> ventilate, keep in a warm place.
144	4 yf.	1.0	1.51	Lt. amber	.....	N. G.	Dump out.
145	.....	1.1	0.91	Pale yellow	.....	N. G.	Dump out.

A glance at the foregoing data shows only six samples of market standard vinegar, Nos. 107, 119, 124, 130, 135, and 136 while as many were utterly worthless. One of these latter samples was actually putrid. It is very evident that one of the common occurrences in the vinegar fermentation is the failure to form acetic acid even when sufficient alcohol is present. The trouble may be due to the uncleanness of the container in which the sweet cider was placed, too cool a storage temperature allowing the multiplication of "vinegar disease" microorganisms, etc. These same explanations will cover also the frequent lack of alcohol in the fermenting liquid. This matter is more fully discussed in the vinegar bulletin.

A marked vinegar bulletin was sent in response to a request relative to a method of clearing vinegar, also to parties in Ohio, Iowa, Idaho and North Dakota as well as in Michigan who made inquiries about the nature of "vinegar bees."

Requests have also come in for information on how to treat apple cider to prevent fermentation and yet to retain its original flavor. Pasteurization was recommended. Two other very similar requests were received for information on cider making and methods of handling cider for beverage purposes. A company in Idaho asked for the best method for preserving cider by means of drugs. They were referred to the Bureau of Chemistry at Washington, D. C.

A company at Monroe, Michigan, asked for a method of making rhubarb wine. The information was given them that rhubarb in and of itself contains too little sugar and too much acid to be fermentable to any extent by wine yeasts and that rhubarb juice whether used as a beverage in the fermented or unfermented state requires the addition of so much sugar as to be almost prohibitive at the present time so far as cost of material is concerned. [Zae Northrup Wyant.]

FOOD INVESTIGATIONS.

Canned corn: A quart mason jar of corn having a very dark greenish black growth on the surface was brought in for analysis. The growth proved to be a mold resembling certain species of *Penicillium* and was not and could not possibly be corn smut as was thought by the owner of the corn. A test of the can showed a defective rubber, allowing the entrance of air as soon as the can was sealed hot. The spores of this particular mold were most probably drawn into the can at the time it was taken from the processing bath and sealed. The mold growth was all removed from the can before testing and although air was drawn in on cooling as before stated, the corn has remained sterile (for two months) so far as visible growth is concerned. This shows that leaky cans may not always become contaminated through the entrance of air. If a leaky can be tipped up, however, so that the juice oozes out underneath the cover, molds and other organisms may grow through the leak just as trees send their roots into a drain tile to get the necessary water.

Canned olives: Several swelled cans of olives were examined bacteriologically for the presence of *B. botulinus*. This organism was not found and it was considered unnecessary to attempt to identify the organisms producing the gas. Recent studies by the Federal Government

of the olive packing industry have shown that certain manufacturers use faulty methods in the fermentation and processing of olives which would favor a very miscellaneous microflora not at all constant in type.

Canned string beans: Practically the whole pack of string beans put up by a local housewife spoiled due to underprocessing, a heavy white sediment being formed. Knowing the conditions under which the beans were grown, a search for *B. botulinus* and flat sour bacteria was made inasmuch as a somewhat offensive odor was evident on opening them and the H-ion concentration of the juice was high. *B. botulinus* was not found, but a very interesting apparently anaerobic thermophile was isolated from them which may have caused the increase in acid. A study is being made of this organism, the results of which will be published later. Neither the bean juice nor the thermophile culture was toxic to guinea pigs.

Canned squash: Several quart mason jars of squash which had started to leak were carefully paraffined by the housewife evidently in an effort to stop the leak. The jar examined contained considerable gas. Cultures from this jar showed a pure culture of a facultative anaerobe producing an orange yellow pigment. These bacteria were gram positive, frequently pointed at one end. Further studies have not been made of these organisms.

Canned peaches: A very small sample of jellied peach juice was brought in to determine what organisms were present. A mold had been growing on this particular can and evidently by some phenomenon of its growth had produced a jellying of the juice as the juice in all other cans of peaches put up at the same time was liquid. The taste of the juice was not altered. On the media employed no growth was obtained. However, this phenomenon will bear further investigation.

Pickled peaches: A quart mason jar of moldy pickled peaches was brought in for determination of the molds present and the method of their entrance. It was not surprising that the peaches spoiled as no rubber had been employed for sealing the jar. It was not considered necessary to determine the types of molds present.

Canned tomatoes: A quart mason jar of tomatoes was brought in for analysis. The tomatoes seemed to be very much disintegrated and soon developed a swell and leak, later becoming moldy. No cultural tests were made.

But few cans of spoiled foods have been examined this year due to a lack of time. However, several points illustrated by these samples may well be brought out, even though they have been mentioned more than once in the past few years. First, a housewife need not expect food to keep which has been underprocessed instead of being heated for the length of time advised by the latest Government directions. Of course these directions which have been worked out on experimental packs, in isolated cases may fail even if followed to the letter, due to the presence of very resistant bacterial spores. I believe that the time period for processing certain types of food may well be lengthened without causing a serious deterioration in quality and thus avoid the spoilage of occasional whole packs. Care should be taken not only that rubbers are placed on cans, but that the rubber is new and of good quality. When the can is sealed, the housewife should listen for a moment to note

whether air is rushing into the can, before inverting it to test it for a leak.

It is useless to paraffin leaky cans. If the can has been undisturbed the leak is due to the growth of gas-producing bacteria or yeasts within the can and paraffining is just a waste of time. It can't stop the leak or the growth of the organisms.

Dried eggs: Two samples of dried eggs were sent in for analysis. Samples were taken for bacteriological analysis and the remainder sent to the Experiment Station chemist for determination of moisture, fat, protein and ash.

Sample.	A1.	G2.
Appearance.....	Orange, flaky, moist...	Yellow, powdery, moist.
Odor.....	Good eggs.	Good eggs.
Bacteria per gm.....	40,000,000	66,000,000
Microscopic examination.....	Occasional large rods...	Large and small rods quite numerous.
Lact. broth ferment. tubes.....	No gas.	No gas.
Moisture, per cent.....	6.82	5.20
Fat, per cent.....	36.41	41.45
Protein, per cent.....	46.16	42.63
Ash, per cent.....	2.80	2.93

Schneider (p. 195, Bacteriological Methods in Foods and Drugs Laboratories) suggests that if the bacterial count exceeds 200,000,000 per cc. (of fresh eggs) the eggs are not suitable for human consumption. Mary Pennington (p. 15, Bul. 224, U. S. D. A.) states that the bacterial count in the liquid egg is one-third that of the dried product so the bacterial count allowable for dried eggs thus would be approximately 600,000,000 per gram and the samples above would come well within the limit.

Misses Esther Severance and Rhea East worked out their Problem Cookery problem under my direction during the winter term. A very creditable thesis on a study of the microorganisms causing flat sour in peas was worked out during this time. Organisms were found resembling ordinary soil spore formers which produce acid anaerobically but not aerobically. This work will be published as soon as examinations can be made of a number of cans of various food products inoculated with representative organisms.

Miss Marian Lowe, another Problem Cookery student worked on the bacteria in spoiled olives. *B. botulinus* was not found in any cans although many types of organisms including morphological types resembling the above bacillus were found present. [Zae Northrup Wyant.]

SOIL INVESTIGATIONS.

At the beginning of this fiscal year as noted in last year's report the concrete compost pit was refilled with a mixture of peat and rock phosphate in the same proportions as employed the previous year with the difference that in place of the small addition of manure employed in the first compost an equivalent amount of the first compost was employed as an inoculum, water instead of liquid manure being used to favor anaerobic conditions.

An extraction by the oil-pressure method was made of the mixture

placed in the pit, the solution obtained in this way to be compared bacteriologically and chemically with samples of the mixture itself.

The water in the observation pit was pumped out and samples were tested for soluble phosphates and for total nitrogen. In fact, the analysis of this water was made from time to time to determine whether there was any increase in these soluble salts.

Date.	Parts per million.			Nitrates.	pH.	Remarks.
	Citrate Soluble P. ₂ O ₅	Total Nitrogen.	Ammonia Nitrogen.			
6-18-19.....	20.5	28.0	10.5	No appreciable amount.	8.9-9.0	Reaction -18.6.
7-5-19.....	Bare trace.	21.8	—	—	—	
7-28-19.....	4.4	20.4	—	—	7.7	
8-7-19.....	—	—	—	—	10+	
8-28-19.....	Good trace.	19.6	—	—	10+	
10-28-19.....	7.6	—	—	—	—	

The analysis made on June 18, 1919 shows the amount of citrate soluble phosphorus in the drainage water at the end of the first composting. This water was all pumped out before the second compost was placed in the pit. The remaining analyses show that there was a considerable increase of the citrate soluble phosphorus in the drainage water of the second mixture during the four months of composting. If the second compost had been left in the pit as long as the first, and the same rate of solution had obtained throughout the period of composting as was noted during the first four months, approximately the same amount of citrate soluble phosphorus would have been obtained in ten months as for the first compost.

The three analyses of total nitrogen on the water from the second compost suggest that denitrification took place to some extent. All chemical analyses with the exception of the pH values were made by or under the direction of Mr. O. B. Winter of the Experiment Station Chemical Laboratory.

Bacteriological analyses were made from time to time of both the second compost and the solution extracted from it, mainly for aerobic and anaerobic cellulose decomposing organisms, for organisms causing the solution of rock phosphate and for bacteria of the *Acetobacter* species. The second compost was removed from the pit in October, 1919, and placed in four large bins from which the first compost had just been removed. After pumping out the water from underneath the false bottom the pit was filled with leaves, mainly oak and maple, raked from the campus (during the months of November, 1919, and April, 1920) and were thoroughly tramped down after each filling, the idea being to imitate the formation of a natural peat from readily available material. A pitcher pump reaching to the water underneath the false bottom together with a distributing trough is being employed to keep the entire mass in an active state of decomposition by pumping the water from the bottom up over the top. A sample of this water obtained early in June was found to be a very dark green, full of gas bubbles and to have a bad odor. Analysis was made of this water for

aerobic and anaerobic cellulose digesting bacteria. Both types were found to be present. Studies, both bacteriological and chemical, are to be made both of the water and the decomposing leaves from time to time.

Small aerobic composts have been made of peat with tri-calcic phosphate, potassium sulfate and calcium carbonate mixtures, inoculated with a water extract of the filter papers obtained in previous experiments which showed the greatest loss of cellulose to determine the most successful combination for rapid destruction of the peat cellulose.

Studies are being made of sulfur bacteria with a view toward isolating those most active in the oxidation of elementary sulfur in soil for the purpose of adding them to sulfur—rock phosphate—peat composts.

A microbial peat decomposition experiment was started this spring which employs eighty-four of the cylinders sunk in the plot near the soil house. Raw peat with various additions and combinations such as rock phosphate, sulfur, clay, sand, the two composts mentioned above, and also a peat-rock phosphate-sulfur-manure compost is employed in the various cylinders. The amount of manure used is only sufficient for an inoculum. Check cylinders of raw peat alone, sand alone, clay alone, sand inoculated with manure, etc., are employed. The cylinders were prepared in pairs, one cylinder of the pair to be left uncropped. The crop employed this season is buckwheat. It is hoped that by a combination of bacteriological and chemical studies and also by the information gained through an observation and analysis of the crop for a period of years that some idea may be gained of the results obtainable under actual conditions.

Two smaller cylinders are being constructed for obtaining the soil solution by the oil-pressure method as very frequently it is not convenient to obtain sufficiently large samples of soil such as the large cylinders demand and the latter cylinders do not work as satisfactorily if they are not packed full. Twenty-five pounds of soil was brought to our station by the agriculturist of a large Hawaiian pineapple plantation for extraction by the oil-pressure method. As this amount is much too small for the large cylinders, this soil will be extracted in one of the smaller ones when they are completed. [Zae Northrup Wyant.]

It has been found desirable to drop "Swine Epidemics" as a major project. This decision resulted from a number of causes including lack of funds, inability to maintain a qualified research man on the problem, and the disappearance of local need for the investigation due to the State's successful control of hog cholera in cooperation with the Federal Bureau of Animal Industry. Furthermore there had been removed from our departmental control and later from the station altogether all work with hog cholera serum. Mr. Cooledge had made a great impression on his problem, "The effect of disease in the cow (with special reference to infectious abortion) on the milk," but he requested that he be permitted to resume studies in the sanitation of market milk supplies. Therefore, Mr. Tweed has been placed in charge of Adams project 1a and Mr. Cooledge has devoted his time to the problem "Market Milk Investigations" which we have substituted for "Swine Epidemics" under Adams 3a.

I cannot speak too highly of Mr. Cooledge's achievements in the brief time that he has been able to devote to the new studies. His results fully justify the radical change in the project. He reports on his work as follows:

"During the past year I have been relieved from teaching and my entire attention has been given to experimental work. The methods for determining the keeping quality of milk and the bacteriological condition of other dairy products are so inadequate that an attempt has been made during the past year to find a method which would give an index of the actual ability of the bacteria and enzymes present in a sample to produce the changes which are of interest to the dairyman and consumer. The outcome of this work, a paper, "The Keeping Quality of Milk as Judged by the Colorimetric Hydrogen-ion Determination" by L. H. Cooledge and R. W. Wyant, was published in the March, 1920, *Journal of Dairy Science*. Short articles describing the method have been published in the Quarterly bulletin and various dairy publications. The development of this new method has made it possible to accumulate a large amount of data upon the action of bacteria in the various dairy products.

The advantages of this method are:

The method provides a simple and accurate means of measuring the activity of bacteria and enzymes present in the milk. The principal advantages over methods now in use are mentioned below.

The method does not measure the number of dead, inert, or living bacteria present in a sample of milk but does measure the ability of any enzymes or bacteria present to bring about changes.

The poorer samples of milk may be picked out at the end of one hour and the best samples given their proper grade at the end of eight hours.

The poorer the keeping quality of the milk, the sooner the results are obtainable.

The cost for material is one tube of broth for each sample tested.

There is no expensive equipment necessary.

A trained technician is not required. Any intelligent person may be trained to grade milk by this method in a few days time.

Over a hundred samples of milk may be easily examined each day if the comparator designed by Cooledge is used.

These advantages should make this method of valuable aid to city milk plants, condenseries, ice cream factories, cheese factories, and city, town and village health departments.

By this method it is an easy matter to determine which of a dairy's patrons are delivering an unsatisfactory milk. Advice in regard to sanitation may then be given where it is needed without causing the ill feeling which results from giving advice to the patron delivering a good grade of milk.

In order to make rapid determinations of hydrogen-ion concentration by colorimetric methods, the writer found it necessary to develop a new comparator which is described in the May, 1920, *Journal of Industrial and Engineering Chemistry*. This comparator will soon be placed upon the market by the Central Scientific Co. A combination comparator and rack for storage has been devised and with a set of standards covering the range of pH necessary in the study of milk

will be put upon the market as a milk testing outfit by Hyuson, Wescott and Dunning of Baltimore. [L. H. Cooledge].

Reference has already been made to Mr. Huddleson's connection with projects 1a and 3b. Beginning with February of this year Dr. H. J. Stafseth was granted leave of absence for one year in order that he might return to his native land, Norway, where he will be in the employ of the Norwegian Government. There has already been submitted to you the manuscript covering the three titles of papers by Dr. Stafseth. (See Tech. Bul. 49.) They are as follows:

Part 1. On the presence of *Bact. abortus* in the deeper layers of the mucous membrane of the non-gravid uterus.

Part 2. A few notes on the isolation and cultivation of *Bact. abortus* with special reference to liver and spleen media.

Part 3. On the possibility of differentiating between infected and immune animals in infectious abortion.

Mr. Huddleson contributes a fourth paper referred to in the opening paragraphs of his report which follows:

My time from October 1, 1919 (date of returning to Station after a two year leave of absence) to December 31, 1919, was devoted entirely to a study of the effect of diseases in the cow on the milk with special reference to infectious abortion.

The problem of developing a means of isolating *Bact. abortus* directly from the milk was studied. The results of this study will be found in a paper submitted together with three papers by Dr. Stafseth as Part 4. The isolation of *Bact. abortus* from milk. A summary of the results are given:

1. The proper medium for the isolation of *Bact. abortus* from milk is liver infusion agar which has been prepared without excessive heating and filtered through glass wool instead of cotton or paper.

2. The growth of *Bact. abortus* in culture is markedly influenced by the H-ion concentration of the medium. It is important that the medium be adjusted in terms of H-ion concentration.

3. The H-ion concentration necessary for the optimum growth should lie between 6.6 and 6.4.

4. The most suitable method for growing *Bact. abortus* from milk is obtained by placing inoculated media in a closed chamber in which 10 per cent of the air has been displaced by CO₂ gas.

5. By incorporating a saturated aqueous solution of gentian violet in medium in sufficient quantity to give the dye a final dilution of 1-10,000, a large per cent of organisms occurring in milk other than *Bact. abortus* may be eliminated. The dye when used in the above dilution has no apparent effect upon the growth of *Bact. abortus*.

6. This technique if carefully followed yields results identical with the guinea pig inoculation method for determining the presence of *Bact. abortus* in milk. Its chief advantage is that it requires only four days to determine the presence of the organism whereas the animal inoculation method requires at least eight weeks.

7. This method may be easily employed in studying a large number of samples of milk, or in detecting the presence of the organism in samples of milk which are often sent to the laboratory for diagnosis.

In January, 1920, the investigations in bovine infectious abortion were resumed and in addition teaching, laboratory examinations for

diagnosis of blood samples for bovine infectious abortion, bacteriological examination of tissues, sputum for tubercle bacilli, swabs from nasal and throat passages, and the preparation of autogenous vaccines have occupied my attention.

Three trips have been made during the year which will be discussed in this report.

In resuming the investigations in bovine infectious abortion, it has been my plan to continue four of the problems which were begun in 1916, to continue studies on two problems on which Dr. Stafseth has already reported and to work out problems which suggest themselves from time to time. The four problems begun in 1916 are:

1. The immunization of cows and heifers against infectious abortion using *Bact. abortus* (Bang).

2. The routes through which *Bact. abortus* gain entrance to the body.

3. The bactericidal effect of different chemical specifics when used *in vivo* against *Bact. abortus*.

4. A study of different strains of *Bact. abortus*.

The problems of Dr. Stafseth's on which studies were continued are:

1. The specificity of the intradermal test and its value in differentiating between infection and immunity.

2. The isolation and cultivation of *Bact. abortus*.

A technical bulletin which details the data and results of the immunization problem is now in the process of preparation.

During the year, there were received 194 blood samples (exclusive of the experimental samples) for the application of the agglutination and complement fixation test for infectious abortion of which 64 or 32 percent gave positive reactions to one or both tests.

Four samples of sputum from humans and five specimens of tissue from chickens were examined for the presence of tubercle bacilli of which one of the former and two of the latter were positive.

There were received a total of twenty different specimens for bacteriological examination.

A trip was made to a farm near Aloha, Michigan, February 3, 1920, for the purpose of ascertaining the cause of an epizootic of abortion and wasting disease in a flock of goats. The findings were reported in the April number of the M. A. C. Quarterly. A summary of the findings is as follows:

The flock of Angora goats (169 in number) was shipped from the southwest part of the United States to northern Michigan in November, 1919, arriving in a partly starved condition. About two weeks after their arrival they began losing their young prematurely at the rate of one to four a day. The symptoms of the wasting disease were a great loss of flesh, general weakness, diarrhea, moving about slowly, drooping of the ears, watery appearance of the eyes, no resistance when handled, appetite unimpaired, occasional bleating and coughing, body temperature elevated and pallor of the visible mucous membranes. The course of the disease usually ran from two to eight weeks. No affected animals recovered.

A small micrococcus was isolated from the heart blood, liver and spleen of affected animals and from the stomach of an aborted fetus.

The organism proved to be *Micrococcus caprinus*. This disease (known

as takosis) and its causative organism was described in a bulletin by Mohler and Washburn of the Bureau of Animal Industry in 1903.

There appears to be no remedial agent for treating affected animals other than isolation of affected animals and the burning or burying of infected material.

March 18, 1920, a trip was made to a farm near Union City, Mich., for the purpose of ascertaining the cause of an epizootic of abortion in sheep. This particular flock consisted of 70 ewes and two rams of which 16 were grades and the remaining number fine wool sheep. The rams were placed with the ewes in the latter part of November, 1919. The feed for the winter and spring consisted of ensilage, corn fodder, oat straw and oats. They were housed in a barn with access to a small feed yard and kept separate from other animals. The owner said they had been in very good flesh all winter and they appeared in good condition when inspected March 17.

The first abortion occurred about February 18, 1920. In all, ten had aborted previous to the visit at the rate of one to four a week. Seven were yearlings and three were 3 to 4 years old. The owner stated that each of the ewes became ill two days before aborting, moved around very slowly and remained by themselves. He also reported having one abortion the previous year. Several farmers in this community have reported the loss of many lambs from premature birth this season.

There was noticed a vaginal discharge from most of the ewes which aborted. It was a viscid, putrid exudate and reddish-brown in color. A necrotic placenta was seen hanging from the vulva of two ewes which had recently aborted.

Blood samples were drawn from the jugular vein of four of the ewes which had aborted and from the two rams for serological diagnosis of bovine infectious abortion. All were found negative.

Three fetuses and one uterus from a ewe which was killed 36 hours after aborting were brought to the laboratory for bacteriological examination. Stained smears made from the meconium of the three fetuses and from the exudate contained in the horns of the uterus showed a gram-positive coccus in single elements and in chains of two, three, and four elements. There were no noticeable anatomical changes in the organs of the fetuses. The uterus from the ewe showed considerable congestion and edema; the mucous membrane and maternal cotyledons of the left horn were covered with a creamy exudate.

Smears on liver agar plates, stab cultures, broth cultures and guinea pig inoculation were made from the meconium of the stomach of the three fetuses and from the uterine exudate of the ewe. The inoculated media were incubated under aerobic and anaerobic conditions and observed daily for two weeks for growth with negative results.

Twenty days after inoculation a pregnant guinea pig (inoculated intraperitoneally with uterine exudate), without showing premonitory symptoms, aborted three fetuses. The pig was killed immediately and together with the three fetuses examined for any anatomical changes. The organs of the pig appeared normal except the uterus which was highly congested and contained within the horns a brownish, turbid, serous fluid.

Cultures were made from the stomach content of the fetus and the uterine exudate of the pig and incubated under aerobic and anaerobic

conditions for a period of ten days. Subsequent examination showed the presence of an organism in the stab cultures (agar plates and broth tubes proved sterile) which possessed the following morphological, biological and cultural characteristics:

Oval micrococcus, 0.8 to 1.0 micron in diameter; single or in chains of two, three or four elements; frequently in pairs; Brownian movement; does not form spores or possess capsule; stains distinctly and uniformly with the aniline dyes and is gram-positive. Cultural characteristics: grows only in stab culture for two months; at present, grows well aerobically in dextrose broth and as fine colonies on slants of liver agar. Dextrose broth, (pH 6.6) a uniform cloudiness is caused by growth of the organism in 24 hours; slight sedimentation at the end of three days, but never complete; no pellicle formation.

Dextrose agar, growth appears upon the surface in 24 hours in the form of small, flatly convex, colorless, transparent, non-granular colonies about 0.5 mm. in diameter. In stab cultures the growth appears within 24 hours along the entire length of the stab as small brownish foci. Gelatin, growth takes place along the line of stab in 24 hours; no liquefaction. Potato, a slight moist glistening growth appeared in 24 hours made up of minute colonies. Litmus milk, acid and slight coagulation produced in 24 hours, firmly coagulated in one mass in 48 hours.

FERMENTATION.

Sugar.	24 hours.		48 hours.		72 hours.	
	Acid	Gas	Acid	Gas	Acid	Gas
Dextrose.....	+	-	+	-	+	-
Maltose.....	+	-	+	-	+	-
Mannite.....	+	-	+	-	+	-
Saccharose.....	+	-	+	-	+	-
Lactose.....	+	-	+	-	+	-

+ Sign=acid or gas production.

- Sign=no acid or gas production.

Further study will be carried on in order to identify this organism and to determine its pathogenic and antigenic properties.

An outbreak of abortion in swine was brought to the attention of this laboratory about March 1, 1920. The fetuses were expelled about four weeks before time as they appeared fully developed and covered over with hair. There were altogether six pregnant sows (pure bred Duroc Jersey) in this herd of which three aborted and then gave birth to normal healthy pigs.

A bacteriological examination of one fetus revealed an organism which gave the same cultural and serological characteristics as *Bact. abortus* (Bang).

Blood samples were drawn from the tail of three sows which had aborted and from two virgin sows. Two of the samples from sows which had aborted were positive and the remaining negative to the agglutination and complement fixation tests for bovine infectious abortion. [I. F. Huddleson.]

Research Associate F. W. Fabian submits the following report:

The work that I have been able to do along experimental lines has necessarily been limited due to the lack of time at my disposal after discharging my obligations as a teacher. However, I have found time to undertake several problems, some of which I am still working on while others I have completed.

Problem 1. Titration of Culture Media.

This problem was undertaken in cooperation with G. L. A. Ruehle, Research Associate, of this station, to compare three methods of titrating culture media to determine the one giving the most uniform and satisfactory results under all conditions. A general outline of the methods, procedure and results obtained follow:

A. The standard procedure: Add 5 cc. of the medium to 45 cc. of distilled water, boil for one minute to expel the CO_2 and then titrate in the presence of phenolphthalein until a faint but definite pink color is obtained, the color remaining for five minutes.

B. Driving off the CO_2 from the water by boiling, then adding the hot medium to be tested and finally titrating as before after the mixture has become cold.

C. Neutralizing the CO_2 in the water with an alkali, then adding the medium to be tested and finally titrating to a permanent end point as in the preceding methods.

It will be noted that the principal distinction between method A and the other two is that A requires titration when hot, while B and C require titration when cold. Methods A and B depend upon boiling to expel the CO_2 in the water, while C depends on neutralization of the CO_2 .

The titrations by the three above methods were done at approximately the same time. Duplicate determinations were made in each case, one of the writers running method B and the hydrogen ion determination by the colorimetric method, while the other ran methods A and C. The titration of each medium were made with each method using all of the eight different waters. It was desired to titrate standard laboratory media having different reactions in water from different sources and differing widely in chemical composition. An N/10 acid potassium phthalate solution was used to titrate back the excess alkalinity, it being the only accurate acid solution available when the need arose. Carbonate free N/20 sodium hydroxide was used to titrate the acidity, every precaution being taken to have the procedure uniform. The results of the titrations using the different methods and the various waters and media will be found in tables 4, 5 and 6.

THE MEDIA.

All media were made according to Standard Methods. The nutrient gelatin table 1, a and b, was made from meat infusion while all other media were made from meat extract cubes. Half of each lot of media was made acid while the other half was left unadjusted.

Table 1.

(a)	Nutrient <i>Gelatin</i> from meat infusion.....	pH=6.9
(b)	Nutrient <i>Gelatin</i> from meat infusion.....	pH=5.6
(c)	Nutrient <i>Gelatin</i> from meat extract cubes,	pH=6.8
(d)	Nutrient <i>Gelatin</i> from meat extract cubes,	pH=5.6
(e)	Nutrient <i>Agar</i> from meat extract cubes.....	pH=*
(f)	Nutrient <i>Agar</i> from meat extract cubes.....	pH=7.0
(g)	Dextrose <i>Agar</i> from meat extract cubes.....	pH=7.0
(h)	Dextrose <i>Agar</i> from meat extract cubes.....	pH=*
(i)	Nutrient <i>Broth</i> from meat extract cubes.....	pH=7.6
(j)	Nutrient <i>Broth</i> from meat extract cubes.....	pH=5.6
(k)	Dextrose <i>Broth</i> from meat extract cubes.....	pH=7.0
(l)	Dextrose <i>Broth</i> from meat extract cubes.....	pH=5.6

*Too acid for indicator used.

WATERS USED.

The waters used for dilution purposes in the titration of the media are self-explanatory. The double distilled water was distilled twice while the ordinary distilled water was distilled but once. The other waters used are all from different sources. The East Lansing water, the college water, and the Lansing water are all from deep wells, these being the sources used for obtaining water in these places. A list of the waters used giving their pH values is found in Table 2 and their chemical composition is found in Table 3. The waters used for dilution purposes in titration with their pH value were as follows:

Table 2.

I.	Double-distilled water.....	pH=5.6
II.	Ordinary distilled water	pH=6.8
III.	East Lansing, city water.....	pH=8.0
IV.	College tap water.....	pH=7.2
V.	Lansing, city water.....	pH=7.2
VI.	Cedar River Water.....	pH=8.0
VII.	Well water, A.....	pH=7.6
VIII.	Well water, B.....	pH=7.8

Analyses of six of these waters (Nos. II, IV, V, VI, VII and VIII) were made for us by the Chemistry department of the M. A. C., Experiment Station and are given in Table No. 2.

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TABLE 3.—WATERS (MG. PER LITER.)

Sample.	Well A.	Well B.	College.	Distilled.	Lansing.	Cedar River.
Total Solids.....	616 0	321 0	256 8	33 6	407 2	442 4
Loss on Ignition	160 0	104 0	86 4	9 6	116 0	121 6
SiO ₂	10 6	16 6	9 7	1 1	9 8	5 8
Fe ₂ O ₃ + Al ₂ O ₃	4 0	5 0	2 8	1 5	6 0	4 8
Ca.....	116 3	69 9	75 4	7 7	87 1	85 3
Mg.....	41 4	26 6	26 4	1 5	30 8	26 7
Na (by Difference).....	16 2	4 4	11 5	0 5	8 3	5 6
CO ₂	189 0	166 0	186 5	16 3	176 3	154 0
SO ₄	119 9	6 8	5 3	0 0	51 8	59 4
Cl.....	41 0	8 0	5 0	0 0	12 0	13 0

PROBABLE COMPOSITION.

CaCO ₃	290 3	174 9	188 4	19 7	218 1	213 3
MgCO ₃	21 0	85 5	92 4	5 2	63 4	36 1
MgSO ₄	119 9	8 5	.....	.....	63 5	74 2
MgCl ₂	21 4	1 6	.....	.....	.....	5 9
Na ₂ CO ₃.....	.....	.....	13 2	1 1	.....	.....
Na ₂ SO ₄.....	.....	.....	7 8	.....	1 5	.....
NaCl.....	41 2	11 2	8 3	.....	19 8	11 2

TABLE 4.—TITRATION OF BROTHS BY THREE METHODS.

No. of cc. N/20 NaOH required to neutralize 5 cc. of media.

Water Used in Titration.	Plain Broth from Cubes pH = 7.6.			Plain Broth from Cubes pH = 5.6.		
	A.	B.	C.	A.	B.	C.
I.....	0.45 0.40	0.2 0.3	0.15 0.2	1.4 1.3	0.85 0.9	1.1 1.0
II.....	0.5 0.5	0.3 0.25	0.15 0.15	1.1 1.05	1.0 1.0	1.0 1.0
III.....	-0.6 -0.2 -0.4	0.0 0.2	0.1 0.1	0.1 -0.5	1.0 1.0	0.9 1.0
IV.....	-0.6 -0.5	0.1 0.15	0.25 0.25	-0.3 -0.3	1.0 1.0	1.0 1.0
V.....	-0.5 -0.65	0.1 0.1	0.1 0.45	0.25 -0.2	1.0 1.0	1.1 1.0
VI.....	0.5 0.5	0.0 0.0	0.15 0.15	0.1 0.3	0.8 0.7	0.95 1.0
VII.....	-0.6 -0.6	0.2 0.3	0.3 0.3	0.1 0.05	1.0 1.0	1.0 1.0
VIII.....	-0.6 -0.6	0.3 0.3	0.35 0.3	0.0 -0.3	1.0 1.1	0.9 0.85
Water Used in Titration.	Dextrose Broth from Cubes pH=7.0.			Dextrose Broth from Cubes pH=5.6.		
	A.	B.	C.	A.	B.	C.
I.....	0.6 0.6	0.3 0.3	0.3 0.3	2.1 2.1	1.5 1.6	2.0 2.1
II.....	0.45 0.5	0.35 0.3	0.4 0.35	2.0 1.95	1.9 1.9	1.7 1.8
III.....	-0.6 -0.4	0.15 0.15	0.2 0.2	-0.3 -0.2	1.2 1.2	1.7 1.8
IV.....	-0.3 -0.2	0.25 0.25	0.1 0.4	0.9 0.3	1.5 1.5	1.7 1.8
V.....	-0.2	0.2 0.2	0.3 0.3	0.3 0.1	1.5 1.6	1.9 1.7
VI.....	-0.2 -0.2	0.0 0.0	0.3 0.3	0.6 0.7	1.6 1.6	1.7 1.6
VII.....	-0.4 -0.4	0.1 0.1	0.1 0.3	0.1 0.3	1.7 1.5	1.8 1.8
VIII.....	-0.2 -0.2	0.3 0.3	0.3 0.3	0.1 0.3	1.5 1.5	1.7 1.8

Note.—The — sign before a reading indicates that the mixture was alkaline in which case it was titrated with N/10 acid potassium phthalate.

TABLE 5.--TITRATION OF AGARS BY THREE METHODS.

No. of cc. N/20 NaOH required to neutralize 5 cc. of media.

Water Used in Titration.	Plain Agar from Cubes pH=7.0.			Plain Agar from Cubes pH=lower than 5.6.		
	A.	B.	C.	A.	B.	C.
I.....	0.6 0.6	0.35 0.3	0.25 0.25	1.7 1.8	1.4 1.2	1.35 1.35
II.....	0.4 0.4	0.3 0.3	0.3 0.3	1.4 1.6	1.4 1.5	1.2 1.3
III.....	0.1 0.2	0.15 0.15	0.3 0.3	0.35 0.7	0.8 0.9	1.3 1.25
IV.....	0.45 0.45	0.3 0.3	0.3 0.3	0.2 0.15	1.0 0.9	1.2 1.2
V.....	0.0 0.0	0.3 0.35	0.2 0.2	0.9 0.6	1.6 1.3	1.1 1.1
VI.....	-0.4 -0.2	0.25 0.3	0.2 0.2	0.8 0.6	1.1 1.0	1.2 1.2
VII.....	0.25 0.25	0.3 0.3	0.2 0.2	0.8 0.45	1.4 1.2	1.2 1.1
VIII.....	0.05 0.0	0.3 0.3	0.3 0.25	0.7 1.2	1.5 1.3	1.2 1.1
Water Used in Titration.	Dextrose Agar (Cubes) pH=7.0.			Dextrose Agar (Cubes) pH=lower than 5.6.		
	A.	B.	C.	A.	B.	C.
I.....	0.6 0.7	0.3 0.3	0.3 0.3	2.15 2.15	1.9 1.8	1.8 1.8
II.....	0.35	0.3 0.3	0.3 0.3	1.9 1.9	1.7 1.7	1.8 1.7
III.....	-0.4 -0.4	0.3 0.25	0.3 0.3	0.7 0.6	1.5 1.5	1.6 1.6
IV.....	0.35 -0.15	0.3	0.3 0.35	-0.5 -0.4	1.2 0.7	1.6 1.6
V.....	-0.3 -0.3	0.4 0.4	0.3 0.2	1.05 1.15	1.5 1.5	1.6 1.75
VI.....	-0.3 -0.35	0.3 0.3	0.3 0.3	1.4 1.5	1.7 0.9	1.95 1.95
VII.....	0.0 0.0	0.4 0.4	0.3 0.3	0.0 1.55	1.3 1.0	1.8 1.8
VIII.....	-0.1 -0.1	0.35 0.3	0.3 0.3	1.9 2.0	1.7 1.7	1.7 1.6

Note.—The + sign, etc., (see Table 4)

*Medium added when hot.

TABLE 6.—TITRATION OF GELATIN BY THREE METHODS.

No. of cc. N/20 NaOH required to neutralize 5 cc. of media.

Water Used in Titration.	Meat Infusion Gelatin pH=6.9.			Meat Infusion Gelatin pH=5.6.		
	A.	B.	C.	A.	B.	C.
I.	2.6 2.5	0.8 0.9	1.2 1.2	3.1 3.4	2.1 2.2	2.0 2.0
II.	2.4 2.5	1.0 1.0	1.2 1.2	2.95 2.9	2.3 2.2	2.25 2.2
III.	2.3 2.2	0.8 0.8	1.1 1.0	2.7 1.9	1.5 1.5	2.2 2.1
IV.	2.6 2.5	1.0 1.0	1.0 1.0	3.0 2.9	2.3 2.2	2.2 2.0
V.	1.2 1.5	1.1 *0.6	1.0 1.1	1.7 1.2	2.1 2.2	2.0 2.0
VI.	2.6 2.0	0.9 *0.3	1.1 1.2	2.4 2.35	2.2 2.2	2.1 2.2
VII.	2.0 2.0	1.2 1.1	1.15 1.2	2.8 2.6	2.3 *1.4	2.1 2.0
VIII.	2.45 1.8	1.0 1.0	1.25 1.35	2.3 2.5	2.4 *1.7	2.0 2.0
	Meat Extract Gelatin pH=5.6.			Meat Extract Gelatin pH=6.8.		
	A.	B.	C.	A.	B.	C.
I.	2.3 2.4	1.9 2.1	1.8 1.8	1.2 2.05	1.0 1.0	1.0 1.0
II.	2.05 2.0	2.0 2.0	1.8 1.8	1.3 1.4	1.2 1.2	1.1 1.05
III.	0.4 1.0	1.7 1.7	1.7 1.8	0.8 0.9	0.8 0.8	1.0 1.0
IV.	0.15 0.75	1.8 1.8	1.95 1.7	1.35 1.75	1.1 1.2	1.05 1.05
V.	1.1 2.0	1.7 1.7	1.8 1.8	0.8 1.1	1.2 1.2	1.05 1.95
VI.	1.5 1.25	1.9 1.9	1.8 1.75	1.4 1.2	1.2 1.2	1.0 1.0
VII.	0.6 0.2	1.7 1.7	1.8 1.7	0.95 0.7	0.9 1.0	0.85 0.9
VIII.	0.7 0.1	1.9 1.9	1.75 1.7	0.35 1.0	1.1 1.1	1.0 1.0

*Medium added when hot.

From an inspection of these tables one notes at once that with method A, extreme variations in the results are possible when waters are used which differ among themselves as do those used in this work. Occasionally there were also considerable variations between duplicate determinations with the same water (see especially Table 6). It was noted that a pink ring of alkaline precipitate formed around the periphery of the solution and then the color gradually spread through the entire mass becoming more intense the longer the solution stood. This accounts for the variations noted but the reason for it is not clear.

On the whole very little difference is to be noted between the results of method B and C, except the greater ease and rapidity of the latter. In general the results secured by method C are less variable than by method B. In a few instances, already mentioned, in which method B was unwittingly varied by adding the medium to the previously boiled water while it was still hot instead of waiting until it became cold, the results (which are marked in the tables with an asterisk) were decidedly lower than the duplicates run in the regular way.

It is hard to account for every change that takes place in a complex system such as we have here. Bjerrum (1) has shown that it is impossible to establish precise relationships between the titre of hot solutions and cold solutions in a complex system such as was used in this work. Redfield (2) has shown that at different temperatures wide variations in the titration of peptones may be procured. Tizard and Whiston (3) have shown the effect of temperature on the color changes of methyl-orange and on the accuracy of titrations. And finally, Clark (4) has shown the fallacy of making titrations of hot culture media. Our data would indicate that when it is necessary to titrate culture media more uniform and accurate results may be obtained by neutralizing the excess of CO_2 with the alkali and proceeding with the titration in the cold. On the whole, therefore, the writers are inclined to think that method C is the most reliable especially where distilled water or water of low salt content is not available. While the hydrogen ion method is generally used in this laboratory, yet we still teach titration and method C is the one taught.

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- (4) Clark. The "Reaction" of Bacteriologic Culture Media. Jour. of Infectious Diseases, Vol. 17, 1915, pp. 109-136.

[G. L. A. Ruehle and F. W. Fabian.]

Problem No. 2. (a) To Determine the Number of Bacteria in Pasteurized Ice Cream with a View to Determine a Bacteriological Standard. (b) A Critical Bacteriological Study of the Process of Manufacturing Ice Cream.

This problem is being worked out in conjunction with the ice cream

department of the Stroh Products Company of Detroit, Michigan. We have been working upon it for six months and considerable data are now available.

Problem No. 3. To determine the Hydrogen Ion Concentration of New Glassware. This problem is about completed. The data will be available for publication at an early date.

Problem No. 4. A Study of the Keeping Quality of Ice Cream as Determined by the Hydrogen Ion Concentration Method.

Seven samples of fermented honey have been analyzed during the year. An unidentified yeast was found in two samples and bacteria in the other five.

Ten samples of diseased bee brood were analyzed. Five were diagnosed as American foul brood and five as European foul brood. [F. W. Fabian.]

Research Assistant R. M. Snyder makes the following report on his work:

Nitrogen fixation studies under Adams project 2c are being continued, and in addition cooperative tests involving various methods of inoculation are being undertaken. A report system has been perfected which has resulted in the return of data from the majority of farms on which inoculation is attempted. In this manner inoculation studies may be correlated with field practice.

In the following table are given the numbers of the various legume cultures sent out during the fiscal year 1919-20, the total being approximately 2000 in excess of any other year. The most significant increases have been in the numbers of alfalfa and soy bean cultures dispensed. The demand for cultures closely reflects the crop practice of the state, and present indications are that the future demand for legume inoculating material will greatly exceed that of the past.

DISTRIBUTION OF LEGUME CULTURES.

July 1, 1919-June 30, 1920.

Month.	*Alf.	S. C.	R. C.	A. C.	W. C.	F. B.	G. B.	S. B.	F. P.	G. P.	C. P.	V.	O.	Total.
July.....	334	36	16	.....	.....	.....	.....	19	.....	.....	13	23	.....	441
August.....	975	130	20	5	.....	.....	.....	29	.....	.....	.....	390	.....	1,549
September.....	123	28	5	1	1	.....	.....	.....	.....	.....	.....	142	.....	300
Oct. to Dec.....	7	.....	4	.....	.....	.....	.....	5	.....	.....	5	33	.....	44
Jan. to March.....	651	259	346	18	2	11	2	11	53	6	5	15	1	1,380
April.....	1,748	726	607	36	3	3	2	52	244	17	12	64	3	3,517
May.....	1,463	491	173	10	.....	90	2	1,266	50	6	97	44	3	3,695
June.....	845	61	27	1	1	62	.....	731	26	2	137	13	1	1,907
Total.....	6,146	1,731	1,198	71	7	166	6	2,113	373	31	269	714	8	12,833

* Alf., alfalfa; S. C., sweet clover; R. C., red clover; A. C., alsike clover; W. C., white clover; F. B., field bean; G. B., garden bean; S. B., soy bean; F. P., field pea; G. P., garden pea; C. P., cow pea; V., vetch; O., miscellaneous.

[R. M. Snyder.]

Mr. W. L. Mallman of the teaching staff has charge of water analysis. It is our policy to do what we can to encourage the protection and improvement of rural water supplies. He submits the following report of the water analysis for the year 1919:

During the past year, 106 samples of water have been examined. Of this number, 56 of the samples were from rural districts. The remaining samples were taken from the college swimming pool.

Out of the 56 samples received from rural districts, 21 samples were reported as unsafe. Seven of these were from shallow wells, four from deep drilled wells, two from springs and eight were of unknown origin.

There have been examined also 12 samples of ice. All were found suspicious, since *B. coli* was found in each case. [W. L. Mallman.]

In conclusion I wish to take this opportunity to express my appreciation of the cordial cooperative spirit which has characterized the attitude of all those the results of whose work are herein recorded and to thank you for your constant advice and assistance.

Respectfully,

WARD GILTNER,

Bacteriologist.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE BOTANICAL SECTION.

Director R. S. Shaw, College.

Dear Sir: During the past fiscal year there have been two changes in the staff of the Section of Botany, as follows:

Mr. H. C. Young, who was transferred to the Experiment Station roll from the College roll in July, 1918, but who left in September of that year to enter the Army, returned to the College and was reinstated on September 1st, 1919. He devotes three-fourths of his time to research as Research Assistant in Plant Physiology, and one-fourth to teaching.

On June 1st, 1920, Mr. J. E. Kotila was appointed Research Assistant in Plant Pathology and was sent to Chatham for the summer to study potato diseases.

The chief lines of investigation have been in Plant Pathology under the immediate supervision of Dr. G. H. Coons, and Plant Physiology with Dr. R. P. Hibbard in charge. I append their reports and beg that you will accept them as part of mine.

Respectfully,

E. A. BESSEY,

Botanist.

East Lansing, Michigan, June 30, 1920.

Professor E. A. Bessey, College.

Dear Professor Bessey: In accordance with your request I herewith submit a report of the work in Plant Physiology for the fiscal year ending June 30th, 1920.

As in previous years, all work has been divided between the Experi-

ment Station and the College—three-fourths time for the former and one-fourth for the latter.

ADAMS FUND WORK.

The Adams project (Adams 2d) entitled "The absorption of solutes with special reference to balanced solutions" was actively pursued. Considerable of the laboratory and greenhouse culture work to establish fundamental principles was completed before the summer of 1918 and the problem was then considered far enough along to begin work in the field on a larger scale. The practical application of this project rests in testing out a plan previously devised in the laboratory for determining the fertilizer requirement for a crop or a soil. The evidence, so far, is very strongly in favor of adopting a certain method, but it will take further field work for a period of several years to be able to draw definite conclusions. The plan should be modified to include the idea of crop rotation.

The first field work was started in the spring of 1918 on an acre of land in Field 10 on the College farm. The results from this experiment, together with other data, are now being brought together for publication. The results show that for that particular soil under investigation and for the then existing climatic and environmental conditions, an application of a three salt mixture containing a large amount of acid phosphate gave the greatest yield of grain. The belief that acid phosphate alone might give as good results was not borne out by this experiment. It seems necessary to add a little of the other two to get the best results. The increase in yield more than pays for the extra cost of the other two fertilizer ingredients.

This work was followed up by three field experiments mentioned in my report for 1919 as being started. The first was laid out on the station farm on poor, sandy soil. The land set aside amounted to about two acres. It was about the best level piece of land available. The crop was oats. The number of fertilizer combinations, exclusive of double combinations and single applications, was twenty-one. This was duplicated for the same total concentration. The concentrations (total fertilizer applications) were two in number, eighty pounds of active ingredients per acre and one hundred and sixty pounds per acre.

The second experiment was run on the farm of L. J. Reed, M. A. C. '13, at Clio, Michigan, on a sandy loam, low in fertility. The amount of land set aside was about three acres and the crop was corn.

The third experiment was run according to the same plan as the two above but on a different type of soil and with a different crop. The soil was a fine sand with considerable organic matter incorporated. The crop was potatoes. This experiment was conducted on the farm of Ezra Levin, M. A. C. '15. No results were gathered from this experiment except what could be observed before harvest. Through a failure to receive a telegram the crop was harvested before we received notice of what was taking place. The results of the other two experiments are being worked up for publication.

In the spring of 1920 before the end of the fiscal year June 30, 1920, one field experiment only was started. Conditions of finances did not warrant the carrying out of our original plan and only a small part of the experiment. This experiment was a repetition of the one for the year

1919. Mr. Gershberg assisted me in the field and laboratory work this past year as in the previous year. A more earnest, more exact, and more careful scientific worker among the younger investigators would be hard to find. His work is above reproach and his interest in the problems is much above the ordinary.

STATE FUND WORK.

As noted in my last report, a new problem was started under this fund. Mr. Young, who was then appointed a Research Associate in Plant Physiology, was assigned the new work. The formal statement of the problem is as follows: "The physiological effect on life processes of certain selected plants when growing under deficient or improper nutritive conditions." Little was done on this problem, since Mr. Young entered the army shortly afterward. On his return last September the work was actively pursued. The sugar beet was the crop selected and the effect of the various salt ratios on the sugar content of the beet the first phase of the problem attempted. The plants were raised in water culture and sand culture. It is too early yet to report on definite conclusions. Much has been learned in regard to methods and differences have been noted in sugar content under different conditions, but considerable has yet to be learned about the general problem of growing root crops in water culture and sand culture.

COOPERATIVE WORK.

In addition to the work mentioned above, the division of Plant Physiology is cooperating in three problems—(1) To study the effect of nitrogenous fertilizers under different conditions and the physiological changes resulting from these applications on the vegetative growth and fruit production of apple trees in their unfruitful condition. (2) The determination of the salt requirement of agricultural plants. (3) A soil temperature survey of the United States and Canada.

The scope of these problems may be outlined as follows:

In regard to the first problem, this department is cooperating with the Horticultural and Soils departments of the College. This problem has been in force since early spring. Several trips have been made by Mr. Young and myself to the particular apple orchard in question and various studies made and many data collected. This problem will be continued for a longer period of time than the present season so a more complete report can be given later.

In regard to the second problem (in cooperation with the National Research Council) considerable progress has been made during the past year. In view of the fact that the outline of work sent out by the Council showed a similarity with lines of work being conducted here we found very little difficulty in taking on this extra work. Three phases of the four which the Council outlined have been completed. The results of the first two were embodied in one report of about thirty typewritten pages and forwarded to the Chairman of the committee in May, and the third phase will be written up for publication as soon as possible.

The third problem is carried on in cooperation with the Ecological Society of America. In regard to this, progress has also been made.

The expenditure of only a little time has been necessary to keep this problem going. Records have been gathered at stated periods,—morning, noon, and night, and record sheets on the thermograph have been changed weekly. This makes the second year that this problem has been in force and we expect to send in a report for the second year in a few weeks. The need of a soil temperature survey throughout the country was first emphasized by members of the American Phytopathological Society in connection with perennation of pathogenic organisms. Following these, others have become interested and now after three years considerable data have been collected from the twenty-nine different stations. A general report can soon be expected.

There is still that crowded condition in greenhouse and laboratory that was noted in my previous reports. Something should be done as soon as possible for such conditions retard and hold back much important work that is now being done, and put off to the unknown future other problems that are pressing for immediate study.

For your sympathy, cooperation, and willing assistance in all the varied lines of plant physiological studies, I wish to extend to you my many thanks.

Very respectfully,

R. P. HIBBARD,

Research Associate in Plant Physiology.

Dr. E. A. Bessey, College.

Dear Dr. Bessey: At your request I present the following report for the year ending June 30, 1920.

The personnel of the section has remained the same. During the month of June, 1920, Mr. J. E. Kotila, who had been employed on a temporary basis to investigate potato diseases at the Chatham sub-station, was appointed on a full time basis to carry on further investigations on potato diseases. He went at once to the Chatham station and has in progress numerous potato disease experiments.

Adams 5b.

This project is entitled: "To determine with some plant pathogenes of the Fungi Imperfecti, biological relations which may give a basis for identification and classification as well as understanding of physiological and life history problems. The Fungi Imperfecti form a group which at present has no basis for classification other than a highly artificial one. Attention will be concentrated on the section of the group represented by the genus *Phoma* and its close allies."

The project is still in progress. Greatest attention is being concentrated upon the matter of technique. During the winter considerable progress has been made through the use of experimental animals and at present the precipitin reaction is being utilized as a means of diagnosis.

The utilization of this latter method to replace the anaphylactic shock method has been made necessary because of the intense reactions which some experimental animals give on the primary injection. This type of anaphylactic reaction, which is of the nature of that described by Novy and DeKruif, has made it desirable to seek the more refined method.

Attention is also being paid to the securing in pure culture of a large number of organisms of the group.

Hatch.

Work under the Hatch Fund consists of the general routine diagnosis and determination of laboratory material in connection with the Plant Disease Survey. About 600 specimens were handled last year. The work on cucumber diseases is financed from this fund.

Investigation of transportational diseases which has been carried on for some time by Mr. Nelson and myself has been continued from time to time. Most important advances have been made in the study of the break-down of the tissues of lettuce, cabbage, and citrus fruits under storage with deficiency of oxygen.

Greenhouse diseases have been investigated and considerable experimental work carried on to determine the feasibility of using lime sulphur as a greenhouse spray for control of tomato leaf mold.

State Funds.

Potato disease investigations:

Seed treatment investigations have been carried on following the plan of other years and a body of knowledge has been developed covering the effects of different times and different strengths of application of certain fungicides. In the main, these corroborate the results of former years. Mr. J. E. Kotila has completed careful investigations of the Black Leg disease of potato, which is very important in the Upper Peninsula.

Bean disease investigations:

Bean mosaic investigations are being carried on by Mr. Ray Nelson and in this work emphasis is being placed upon the nature of the infectious material and its method of dissemination in the field.

Celery disease investigations:

Excellent progress has been made in the solution of the celery stunt disease, in that Mr. Nelson completed decisive experiments and has shown that this disease is typical Fusarium Wilt. Seed from a resistant plant has been obtained and tests of this seed are at present in progress. Work on the Phoma disease of celery is being prepared for publication.

Cereal disease investigations:

Samples of Red Rock wheat sent to the College for certification have been tested for relative prevalence of smut. These samples when planted gave varying amounts of smut in the crop. The experience has given an index as to the amount of smut which may be tolerated in wheat to be used for seed purposes. Further field tests of various methods of treatment have shown that for complete control of stinking smut the method in which the grain is immersed in water and the smut balls skimmed off must be used. The so-called sprinkling method which is commonly employed will not completely eradicate smut from the grain, although it will reduce the smut of an excessively smutty sample to an extremely small amount. The dry method works excellently with a fairly clean sample and reduces smut almost to the vanishing point, but not as a clean-up measure for severely infested grains.

Publications:

Aside from occasional articles in the Quarterly Bulletin the writer has completed an article on Aster Wilt for the Michigan State Florists' Annual Report, and a Report on the Plant Diseases in Michigan for 1919 will appear in the Michigan Academy of Science Report in the same

publication. Joint articles with H. H. McKinney and Miss G. Gillette upon Formaldehyde Injury to Wheat and Phenol Injury to Apples will also appear.

The Experiment Station work in Plant Pathology is sadly hampered because of lack of room. This is especially true with reference to greenhouse facilities. I urge again the necessity of providing more extensive facilities for carrying out the many lines of work detailed to this division.

I wish to thank you for the counsel and advice on the many problems which have been before us and to commend the loyal and enthusiastic cooperation of my colleagues.

Very truly yours,

G. H. COONS,

Associate Botanist.

REPORT OF THE CHEMICAL SECTION.

Director R. S. Shaw:

I submit herewith a brief report of the work carried on by the Chemical section for the year ending June 30th, 1920.

Several changes have occurred in the personnel of the staff during the year. Mr. E. A. Hebard was, on account of ill health, forced to resign December 1st, 1919. Mr. F. F. Hebard who had formerly served the department as inspector, was appointed to fill the vacancy and he in turn resigned April 1st, 1920. Mr. E. A. Hebard had, in the meantime, fully recovered his health and was again appointed inspector April 5th, 1920. Miss Arnot Lewis, resigned February 21, 1920, to accept a position with the Detroit Creamery Co. of Detroit at a considerable increase in salary. On April 30th, Mr. E. F. Berger resigned to accept a position with the Corona Chemical Co., Milwaukee, Wisconsin, and Mr. C. F. Barnum resigned June 15th to become associated with the State Farm Bureau.

These resignations affected, for a time, the work of the inspection division, but by transferring Mr. O. B. Winter from the research division to the inspection division with the title of Assistant Chemist, we have been able to continue the work without serious interruption. To fill the vacancy caused by the transference of Mr. Winter to the inspection division, Miss Selma L. Bandemer, a graduate of the University of Michigan, has been recommended for appointment.

CONTROL WORK.

Fertilizer Inspection: During the official year ending April 30, 1920, 374 fertilizer brands were licensed for sale in the State. From May 1st until June 30th this year, 391 brands have been licensed which is more than has ever before been licensed in any one year. The results of inspection for 1919 are published in Bulletin No. 287.

Feeding Stuffs Inspection: Bulletin No. 285 containing results of inspection covering 1530 samples of feed was published in September, 1919. During the year just closing 1036 samples have been analyzed. Many conditions, such as freight congestion, strikes and high prices

have operated to curtail the feed business during the past year. Evidence of violation of the Federal Food and Drugs act, which also constituted violations of the State law, covering 40 cases was submitted to the U. S. Department of Agriculture for prosecution by the Department of Justice. In the majority of cases our evidence has been sustained. Special mention should be made of the cases against E. P. Mueller, a Chicago broker. During the summer of 1919 several cars of low grade ground screenings were sold by him through the western part of the State. It was represented to be "Ground Barley and Flax" in some cases and in others "Pea and Barley Feed." Evidence was obtained covering five of these shipments, four of which the Department of Agriculture has recommended for prosecution. Mr. Mueller is also under indictment brought by the Grand Jury in the Western District of Michigan on evidence furnished largely by this department for profiteering in connection with one of these cases.

Insecticide Inspection: Eighty-seven samples of insecticides and fungicides were collected during May and June and are now being analyzed. The results for last year's inspection will be contained in the Report of the State Board of Agriculture for the year ending June 30th, 1920.

HATCH FUND.

The study of the "Alkaline Permanganate Method" which is now being widely used for the determination of available nitrogen in fertilizers has been carried on during the past year and it is expected that the work will be completed in the near future. The results will be of interest, especially to fertilizer and control chemists.

A rapid method for the analysis of limestones and marls has been developed by Mr. Robinson. The results of this work will be published in a forthcoming number of "Soil Science" as scientific paper No. 15.

A study of the cause of foliage injury when magnesium and calcium arsenates are used for spraying purposes was investigated during the year. This was published in the Quarterly Bulletin, Vol. 2, No. 2.

ADAMS FUND.

Project 2b. "A study of physico-chemical aspects of soil acidity." Very little has been done on this project during the year due chiefly to a concentration of effort on other problems. It is expected, however, that this work will be actively resumed very soon. A preliminary paper describing the work that has already been done on the soil acidity phase of the subject was published by Mr. Winter, in "Science," Vol. 51, No. 1305.

Project 2ba. "The organic nitrogenous compounds in peat soils." Mr. Miller has devoted his attention to this subject during the year and has succeeded in isolating aspartic acid in considerable quantity as one of the products in the hydrolysis of peat. This has an important bearing from the agricultural standpoint inasmuch as aspartic acid may be utilized as food by bacteria.

Project 2e. "A study of the preparation and properties of pure vegetable proteins." Only a small amount of preliminary work has been done on this project. Active work has been delayed in order that the

study of the alkaline permanganate method for determining available nitrogen might be completed. It is expected that active work will be begun in the near future.

MISCELLANEOUS.

Two hundred thirty-nine samples of a miscellaneous character, including 52 soil samples submitted by Mr. J. A. Jeffrey from Ontonagon county were analyzed during the year. In addition a large number of marl samples were tested for lime content and many soil samples were examined for lime requirement.

The writer attended the annual meetings of the Association of Official Agricultural Chemists and Association of Feed Control Officials in Washington, D. C., November 17-19th inclusive and 20-21st inclusive.

In closing permit me to thank you for your continued interest in this section and to acknowledge, with deep appreciation, the loyal support and earnest endeavors of those associated with me in the work.

Respectfully,

ANDREW J. PATTEN,

Chemist.

East Lansing, Michigan, June 30, 1920.

REPORT OF INSECTICIDE AND FUNGICIDE INSPECTION.

REPORT OF

ANDREW J. PATTEN.

To the State Board of Agriculture:

During the year 1920, 73 samples of insecticides and fungicides have been collected and analyzed. The sampling was done by Mr. E. A. Hebard and the analytical work was performed by Mr. Glenn C. Forrester, a graduate student from the University of Michigan. The results are presented herewith.

LIME SULPHUR SOLUTIONS AND SUBSTITUTES.

Only two samples of lime-sulphur solution were collected, owing to the fact that the inspection was not started until after the spraying season was nearly over.

Some attention was given to the filling of barrels and some complaints of short measure were received. Several barrels of a shipment made by the Jas. A. Blanchard Co., St. Joseph, to the Berrien County Fruit Exchange, Coloma, Michigan, were tested and found to be short from two to four gallons per barrel. Owing to certain circumstances in connection with the case over which we had no control, no action was taken. It is believed, however, that a repetition of the practice will not occur.

LIME SULPHUR COMPOUNDS—SOLUTIONS.

No.	Manufacturer.	Baume.		Total Sulphur.		Sulphur as Thio-sulphate. Per cent.
		Found.	Guaran- teed.	Found. Per Cent.	Guaran- teed. Per Cent.	
507	South Haven Chemical Co., South Haven Mich.....			26.5	25	0.6
506	San-O-Cide Spray Co., Fennville.....			26.8	25	0.6

DRY PREPARATIONS.

486	Sherwin-Williams Co., Chicago Ill.....	61 2		6. 4
585	Sherwin-Williams Co., Chicago, Ill.....	64 4		7 2
574	Detroit White Lead Works, Detroit, Mich.....	63.6		

ARSENATE OF LEAD.

Three samples of arsenate of lead paste and nineteen of the powder form were analyzed. One sample of paste (501) contained in the original package was found to contain more than 50 per cent of moisture and less than the legal requirement of arsenic oxide (As_2O_5). Five samples of dry arsenate of lead manufactured by H. J. Smith & Co., Utica, New York, were analyzed. Three of these (Nos. 589, 590 and 591) were found to be mixtures of lead arsenate and calcium arsenate with a preponderance of the calcium arsenate and an excess of calcium carbonate. These cases were referred to the Federal Insecticide Board and a Federal inspector was sent to the State to take charge of the matter. Settlement was made by the company covering these cases.

Two samples (Nos. 489 and 508) manufactured by the Toledo Rex Spray Co., Toledo, Ohio, were found to be slightly below guarantee for total arsenic oxide.

ARSENATE OF LEAD (PASTE).

No.	Manufacturer.	Moisture. Per Cent.	Lead Oxid (PbO).		Arsenic Oxid (As_2O_5).			
					Total.		Soluble.	
			Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.
501	Detroit White Lead Works, Detroit	53 19	30 78	.....	14 23	15 00	0 07	0 75
26	Grasselli Chem. Co., Cleveland, O.	49 80	32 61	.....	15 51	15 00	0 06	0 75
584	Dow Chemical Co., Midland,	47 80	32 00	.....	17 00	15 00	0 28	0 50

ARSENATE OF LEAD (DRY POWDER).

No.	Manufacturer.	Lead Oxid (PbO).		Arsenic Oxid (As ₂ O ₃).			
				Total.		Soluble.	
		Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.
500	Ansbacher Insecticide Co., New York, N. Y.	64.4	.....	29.7	30.0	0.74	1.0
498	DeVoe & Reynolds, New York, N. Y.	64.4	63	31.3	31.0	1.74	1.0
560	Hazeltine & Perkins, Grand Rapids.	64.6	.....	31.4	.....	0.02	.....
577	Imperial Chemical Co., Grand Rapids.	63.7	.....	32.2	30.0	0.38	1.0
518	Corona Chemical Co., Milwaukee, Wis.	64.8	.....	31.1	30.0	0.12	0.50
528	Corona Chemical Co., Milwaukee, Wis.	62.9	.....	33.3	30.0	0.05	0.50
490	Dow Chemical Co., Midland.	64.4	.....	32.4	30.0	0.36	0.65
504	The Glidden Co., Cleveland, Ohio.	62.3	.....	31.8	31.0	0.04	0.50
576	Niagara Sprayer Co., Middleport, N. Y.	63.6	.....	31.8	30.0	0.15	0.50
495	San-O-Cide Spray Co., Fennville.	64.1	.....	31.2	30.0	0.95	1.0
488	Sherwin-Williams Co., Cleveland, Ohio.	64.4	.....	32.4	30.0	0.20	1.0
589	H. J. Smith & Co., Utica, N. Y.	1.5	.....	19.4	.....	1.25	.....
537	H. J. Smith & Co.	69.6	.....	26.9	31.0	0.21	0.75
590	H. J. Smith & Co.	2.0	.....	19.6	.....	0.35	.....
591	H. J. Smith & Co.	4.5	.....	17.8	.....	1.45	.....
592	H. J. Smith & Co.	65.4	.....	29.9	31.0	0.14	0.75
489	Toledo Rex Spray Co., Toledo Ohio.	67.1	.....	29.7	31.0	0.29	0.50
508	Toledo Rex Spray Co.	66.9	.....	29.3	31.0	0.33	0.50

CALCIUM ARSENATE.

Six samples of calcium arsenate and one of magnesium arsenate were collected and analyzed. All of these samples contained arsenic oxid equal to the guarantees. One sample (496) contained an excess of soluble arsenic oxid.

CALCIUM ARSENATE.

No.	Manufacturer.	Calcium Oxid (CaO).		Arsenic Oxid (As ₂ O ₃).			
				Total.		Soluble.	
		Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.
509	Ansbacher Insecticide Co., New York, N. Y.	29.3	.....	39.6	40.0	0.64	1.50
575	Corona Chemical Co., Milwaukee, Wis.	44.2	.....	47.9	42.5	0.30	1.50
497	DeVoe & Reynolds, New York, N. Y.	43.1	.....	42.4	40.0	0.41	0.75
570	DeVoe & Reynolds, New York, N. Y.	43.4	.....	42.5	40.0	0.98	0.75
543	Riches-Piver & Co., Hoboken, N. J. "Cal-Arsenate"	40.5	.....	39.7	40.0	0.81	1.15
496	Commercial Chemical Co., Memphis, Tenn. "War on Potato Bugs"	42.1	.....	43.0	40.0	1.8	0.75
494	Dow Chemical Co., Midland, Mich. "Magnesium Arsenate"	.....	.....	33.0	.....	1.3	.....

PARIS GREEN.

Five samples of Paris Green and one of "Bug Finish" (a mixture of 90 parts gypsum and 10 parts Paris Green) were analyzed. All of the samples were found to be satisfactory as regards total and soluble arsenious oxid.

PARIS GREEN.

No.	Manufacturer.	Arsenious Oxid (As ₂ O ₃).				Copper Oxid Cuo. Per Cent.
		Total.		Soluble.		
		Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.	
566	Detroit White Lead Works, Detroit, Mich.	53.1	50.0	1.5	3.5	30.5
579	DeVoe & Reynolds, New York, N. Y.	54.7	50.0	1.4	3.5	29.5
569	Fred L. Lavenburg Co., New York, N. Y.	52.9	50.0	1.8	3.5	29.4
491	Nitrate Agencies Co., New York, N. Y.	51.3	50.0	2.3	3.5	29.2
561	St erwin-Williams Co., Cleveland, Ohio	53.4	50.0	1.0	3.5	30.2
505	Bug Finish, Mich. Gypsum Co. Grand Rapids, Mich.	1.2	0.4	0.1	0.3	.....

BORDEAUX MIXTURE.

Nine samples of Bordeaux mixture and one sample of Magnesium Bordeaux mixture were analyzed. All of these were dry preparations and exceeded the guarantees for copper.

BORDEAUX MIXTURE.

No.	Manufacturer.	Copper (Cu).	
		Found. Per Cent.	Guaran- teed. Per Cent.
499	Ansbacher Insecticide Co., New York, N. Y.	12.0	12.0
530	Corona Chemical Co., Milwaukee, Wis.	12.0	11.0
587	Corona Chemical Co., Milwaukee, Wis.	11.8	11.0
502	Detroit White Lead Works, Detroit, Mich.	11.9	11.0
571	Detroit White Lead Works, Detroit, Mich.	12.0	11.0
542	Hammond's Paint & Slug Shot Works, Beacon N. Y.	12.7	12.5
578	Imperial Chemical Co., Grand Rapids, Mich.	11.4	11.0
487	Sherwin-Williams Co., Cleveland, Ohio, "Fungi-Bordo"	11.7	11.0
533	Sherwin Williams Co., Cleveland, Ohio, "Fungi-Bordo"	12.3	11.0
511	Dow Chemical Co., Midland, Mich., Magnesium Bordeaux Mixture.	25.7	25.0

BORDEAUX ARSENATE MIXTURES.

Four samples representing four manufacturers were analyzed. One sample (572) was below guarantee in total arsenic and copper. For a more complete discussion of this class of material the reader is referred to Special Bulletin No. 96 published in May, 1919.

BORDEAUX ARSENATE MIXTURES

No.	Manufacturer.	Water.	Arsenic (As).				Copper (Cu).		Lead Oxid PbO. Per Cent.
			Total.		Soluble.		Found. Per Cent.	Guaran- teed. Per Cent.	
			Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.			
503	Bowker Insecticide Co. Boston Mass., "Pyrox"	69.4	4.3	3.4	0.04	0.8	2.1	1.5	12.9
572	The Glidden Co., Cleve- land, O., "Bordo Arse- nate"		8.4	10.1	0.07	0.3	9.4	11.0	38.8
519	Sherwin Williams Co., Cleveland, Ohio, "Insecto"		2.6	2.8	0.14	1.0	9.6	10.5	9.0
536	H. J. Smith & Co., Utica, N. Y., "Hexpo"		5.0	4.5	0.10	0.3	16.7	15.4	15.4

DUSTING MATERIALS.

Seven samples, all manufactured by the Niagara Sprayer Co., Middleport, N. Y., were analyzed. These were, for the most part, dry mixtures of lead arsenate and sulphur in varying proportions. Some contained dry Bordeaux mixture and others nicotine.

DUSTING MATERIALS.

No.	Manufacturer.	Arsenic (As).				Sulphur (S) Per Cent.	Lead Oxid (PbO). Per Cent.
		Total.		Soluble.			
		Found. Per Cent.	Guaran- teed. Per Cent.	Found. Per Cent.	Guaran- teed. Per Cent.		
512	Niagara Sprayer Co., Niagara 95-5 Mixture....	1.2	0.97	0.17	0.26	95.4	2.28
513†	Niagara 3-1 Dusting Mixture.	2.2	1.95	0.42	0.50	50.2	4.29
514†	Niagara All in One Mixture.....	1.9	1.95	0.38	0.50	61.6	3.59
515	Niagara 90-10.	5.7	.....	0.20	.....	89.2	.....
516*	Niagara Potato Mixture.	2.0	1.95	0.14	.....	71.6	6.2
517	Niagara 80-10-10 Mixture.....	2.0	1.95	.....	0.50	77.8	4.32
541†	Niagara All in One Mixture.....	1.94	1.95	0.38	0.50	61.6	3.59

†Copper (Cu) 2.28 per cent.

*Nicotine identified.

MISCELLANEOUS MIXTURES.

534. Bug Death, Manufactured by the Danforth Chemical Co., Leominster, Massachusetts.

	Guaranteed	Found
Zinc Oxid (ZnO).....	47.0%	50.5%
Lead Oxid (PbO).....	5.0%	6.5%

538. Bug Death Aphis, Manufactured by the Danforth Chemical Co., Leominster, Massachusetts.

	Guaranteed	Found
Zinc Oxid (ZnO).....	15.0%	11.6%
Lead Oxid (PbO).....	1.0	4.8
Calcium Oxid (CaO).....	20.0	10.9
Sulphur (S).....	20.0	21.6
Tobacco Dust.....	10.0	Identified

532. † Tuber Tonic, Manufactured by Sherwin Williams Co., Cleveland Ohio. A mixture of Paris Green and Bordeaux mixture.

	Guaranteed	Found
532 Total Arsenic (As).....	24.0%	24.5%
Soluble Arsenic (As).....	3.0	3.0
Copper (Cu).....	.....	23.9
583 Total Arsenic (As).....	5.1	4.6
Soluble Arsenic (As).....	0.4	1.1
Copper (Cu).....	.....	12.0

492. Hammond's Slug Shot. Manufactured by Hammond Slug Shot Works, Beacon, N. Y. Guaranteed to contain Sulphur 6%, Copper Sulphate 1%, Copper Arsenite 1.50%, Crude Carbolic Acid 0.4%, Nicotine trace, Inert ingredients 91%.
Results, No. 492.

Arsenic (As).....	0.9%
Soluble Arsenic (As).....	0.2
Copper (Cu).....	0.8
Sulphur.....	21.2
Nicotine.....	trace
Carbolic Acid.....	identified

580. "Black Leaf 40." Manufactured by Kentucky Tobacco Products Co., Louisville, Ky. Guaranteed nicotine 40.0%. Found 41.1%.

563. Dr. Hess Instant Louse Killer. Manufactured by Dr. Hess & Clark, Ashland, Ohio. This proved to be a mixture of ochre and hydrated lime containing naphthalene, tobacco dust and crude carbolic acid.

567. Dr. Le Gear's Lice Killer. Manufactured by D. L. D. LeGear Medical Co., St. Louis, Missouri. Guaranteed Nicotine 0.24%, Sulphur 30%, Inert ingredient 69.76%. Found Sulphur 29.2%. Nicotine identified.

523. |
 524. | -El-Vampiro. Manufactured by Allaire Woodward & Co., Peoria, Ill. Guaranteed Pyrethrum
 531. | flowers 85%, Inert ingredient 15%. Pyrethrum was identified in all samples.
527. Nichols Bed Bug Powder. Manufactured by Chas. H. Nichols & Co., Chicago, Ill.
 Guaranteed Pyrethrum powder 25%, Inert ingredient 75%. Pyrethrum identified.
588. Evan's Kill Em Quick. Manufactured by Evans Manufacturing Co., Battle Creek Mich.
 Guaranteed Pyrethrum flowers 95%.
- Insert ingredients 5%.
 Pyrethrum identified.

REPORT OF THE ENTOMOLOGICAL SECTION.

Director R. S. Shaw:

Dear Sir: Following is a brief report of the work of the Division of Entomology for the year ending June 30, 1920.

The season of 1920 seems to be a banner year for all sorts of insect troubles.

During the year, there have been no changes in personnel of the regular salaried members of the section of Entomology. Additional help became necessary in order to carry on an investigation on codling moth and Mr. L. J. Bottimer has been employed during part of June to make this possible, also the title of Miss Eugenia McDaniel was recently changed to Research Assistant in Entomology.

During the year just completed there has appeared a bulletin on the *Lecania* of Michigan, which has been for some time in the hands of the printer. This bulletin, by the writer and Miss Eugenia McDaniel, places on record the results of many years of collecting. The genus *Lecanium* belongs to the soft scales and the species offer special difficulties in their recognition. To this genus belongs the so called New York Plum scale, the Apricot scale; a species on grape, the large soft scale of peach, and the terrapin scale of peach. All of which together with others, look very much alike except to the specialist. It is hoped that the bulletin will help to make more reliable and accurate any experiments to be carried on in the future. Besides this, several articles by members of the section, have appeared in the Quarterly and in the Journal of the American Association of Economic Entomologists.

A Parasitological problem which has been successfully pursued during the past year is the treatment of intestinal protozoal diseases of man and domesticated animals with Neosarsphenamin. The results of these investigations have pointed out a method for successfully treating intestinal diseases which have heretofore been considered incurable. Also, primarily of interest to agriculture, it appears that it may, as the result of this work, be possible, not only to control through medicinal treatment, epidemics of intestinal protozoal diseases of both man and food animals under conditions where control through sanitary methods would be difficult if not impossible. An opportunity has also been presented for determining the pathogenic importance of numerous various species of protozoa which infest the intestines of domesticated animals. A paper by Dr. Chandler and Dr. Carr of Lansing reporting the successful treatment of "Trench diarrhoea" (Giardiasis) in man with Neosarsphenamin was published in the May 12th issue of the Journal of the American

Medical Association. Other reports dealing with a great number of organisms are being prepared by Dr. Chandler and will shortly be published.

During the winter plans were made and work started on an extensive experiment whose final object is to determine the time of flight of the first generation of codling-moth and consequently the time of entrance in the apple of the larvae of the second generation, so that it may be possible to set the date more exactly for the August spraying, in other words to catch the greatest number possible of the young "worms" of the August generation just as they are about to enter the fruit. This involves the establishment of twelve stations for rearing the adults in cages and the computation of the optimum dates for spraying in as many other localities as possible. To make these computations we are utilizing the work of Dr. A. D. Hopkins of the U. S. Bureau of Entomology, who has devised a method of computing the progress of natural events based on observations made over the entire United States over a long period of years. This project promises great returns if it is possible to correct our computations for the influence of Lake Michigan, and certain soil conditions.

Studies in the control of household pests have yielded some results, most notably in the control of the large American roach, a report on which was published in the *Journal of Economic Entomology*.

Another note also published in the *Journal of Economic Entomology* deals with the apparent discovery that the serious attacks of the buffalo tree-hopper in Michigan which sometimes occurs in young apple trees, almost invariably follows the setting of new orchards in alfalfa or some plant that remains succulent late in the season, or at least the close proximity of some such succulent plant, usually alfalfa or in a lesser degree of red raspberries. These plants furnish ideal feeding places for the tree-hopper late in the season and the young trees furnish a natural place for oviposition. Consequently young trees under such conditions are often deformed or killed outright. When the trees are larger, they are able to withstand these attacks and escape with a few scars.

The work in animal parasites is progressing satisfactorily. The experiment with ox-warble is being repeated with variations this year, using six calves. Last seasons attempt seemed to show that the adult flies of the ox-warble, in captivity, refuse to lay their eggs on calves. It is, naturally, too soon to get the results of the trial now and will be until next Spring.

The experiments with gape-worms are being continued in the hope that they may run through the winter in the animal house now under construction. This house will be built of brick with suitable quarters for a limited number of animals and will contain a small laboratory at one end designed for the rough work in post-mortems and for fecal examinations. It should facilitate the work very materially.

Dr Chandler reports that the experiment in soil treatment for stomach worms of sheep, is nearly complete for this season. It remains merely to post-mortem the animals and check up on the findings.

The Hessian-fly situation is growing worse, as was expected. There seems to be a dearth of the natural enemies of this serious pest and no amount of urging would prevail on the wheat-growers to actually sow

on fly-free dates, consequently much of the wheat was sown early, some of it very early with the result that the advance of the fly in the southern third of the State was not checked. Examinations of such fields last fall and this Spring showed an abundance of the puparia in the plants and, now the wheat in the extreme southern part of the State is beginning to lodge so that the loss is apparent to any one. This condition will become apparent farther north as the grain nears maturity.

Tip-burn of potatoes was very bad in 1919, and it is beginning to show now in 1920. The cause is a small leaf-hopper, whose winter quarters are still somewhat of a mystery. This trouble has only recently been traced to its real cause and thus far all attempts to control it have been disappointing rather than otherwise.

The following new pests have appeared in our State during the season of 1919 and 1920, *Anametis griseus*, a snout beetle on apple which attacks the bark and buds. It is also recorded on peach.

The spruce tortrix, *Argyrophora abietana*, a small green "worm" that attacks the buds and tips of the twigs and binds them up with webbing. It was quite serious among ornamentals in Detroit and vicinity. The spruce budworm, *Tortrix fumiferana*, a pest with a very bad record in the East, especially in New England and Canada where it was very destructive to spruce, balsam, fir, larch, hemlock, and white-pine, about ten or twelve years ago.

The Oriental fruit-moth appeared in its larval form in quantities, in shipments of peaches from the south. It is almost certain to have gained a lodgement in our State, since carloads of infested fruit were scattered pretty well over Michigan. This pest has a bad record in other parts of the United States and the worst feature about it is that it is very difficult, if not impossible, to control. No efficient measure has as yet been found.

Among our old standbys several destructive pests stand out conspicuously as troublesome. The Chrysanthemum midge has been plentiful.

Flea-beetles, especially the potato flea-beetle and the pale striped flea-beetle have been and are now very troublesome.

Cabbage-maggots, and onion-maggots have been plentiful but fortunately the bean-maggot has not made itself felt so much as usual.

The clover leaf-beetle was pretty wide spread during the late summer of 1919.

A slight touch of army-worm occurred in the "thumb" in August and strawberries, cherries and raspberries have suffered from their respective sawflies quite severely.

The joint-worm attack of 1918 has practically subsided as was to be expected from the multitude of parasites that developed and which were discussed in our last report.

Respectfully submitted,

R. H. PETTIT,

Entomologist.

East Lansing, Mich., June 30, 1920.

REPORT OF THE HORTICULTURAL SECTION.

Director R. S. Shaw:

Dear Sir—The experimental work of the horticultural section the past year has consisted of a continuation and development of many of the projects previously reported and the initiation of some new projects that seemed desirable.

During the past year further investigations were made of spraying and dusting fruits and vegetables for the control of the common insects and diseases of fruits and vegetables. There were some very important results obtained from this work which may be briefly mentioned at this time.

The lime-sulfur solution is now considered a standard material to use as a dormant spray for scale and as a summer spray on apples and some other fruits to control fungus diseases. The inconvenience and expense of the distribution, over a large marketing area, of this liquid form of the compound make it desirable, on the part of the manufacturer, to market it in the form of a powder. Experiments of the past season indicate that this dry lime sulphur, used at the strengths recommended by the manufacturers, is not as efficient for summer spraying as the liquid form. In view of the fact that in many rural towns the local agents of spray materials have discontinued handling the liquid form for the dry lime-sulphur, the inefficiency of the powdered forms should be more generally known.

Extensive tests were also made of the numerous arsenical compounds being offered for spraying purposes. Tests of calcium arsenate on apples and peaches showed severe foliage injury. When lime was used with the calcium arsenate, foliage injury was still considerable, but less than when used alone. Therefore, we cannot recommend the use of this material for spraying such fruits. On potatoes, however, calcium arsenate proved a very satisfactory material, giving good results on insect control and doing no injury to the foliage.

The use of magnesium arsenate on peaches and apples also resulted in severe foliage injury, and, therefore, at the present time it cannot be recommended for fruit-tree spraying. Arsenate of lead still remains the standard arsenical compound for fruit spraying, but unless it is used with Bordeaux mixture or lime-sulfur solution, two pounds of lime should be added to each fifty gallons of the spray to prevent burning.

The comparative tests of lime-sulfur dust with lime sulfur spray were continued and showed just as efficient control of scab and codling-moth worm with the dust as with the spray. On sour cherries, however, the dust did not control the shot-hole fungus quite so efficiently as the lime-sulfur spray. A comparative test of the dust and various sprays on currants and gooseberries proved that Bordeaux mixture was the most efficient spray in controlling the anthracnose. Further details of the results of our spraying and dusting experiments will be found in Special Bulletin No. 102, published recently.

The fruit tree record work previously reported has been continued and

is showing some excellent results in the difference in color and storage quality of the two distinct types of Baldwin apples that have been discovered in this orchard.

Additional data has been obtained the past year on the storage of fruits by freezing, a detailed account of which we hope to publish in the near future.

The lack of regular production of many of the orchards of Michigan is due to a starved or half-starved condition of the trees. To meet the immediate demand for information on fertilizing orchards and to stimulate better cultural practices to insure a bountiful supply of moisture and plant food to producing trees, a circular of general information on this subject was recently published (Circular 43).

Orchard fertilizer demonstrational tests were also started in many localities of the fruit sections through the cooperative efforts of our experimental and extension forces. In the Thomas Quinlan orchard of Grand Rapids an investigation has been started of the nitrogenous requirements of a typically starved orchard. This project is in cooperation with the Soils and Botanical departments.

At the South Haven Experiment Station the work the past season has consisted largely of caring for the numerous young trees recently planted, and of the many seedling crosses that were made in the experiments to obtain a desirable blight-resistant pear and a hardier peach, the two principal lines of work being developed there at present. The property has been maintained in a very tidy and respectable manner and some landscape gardening improvements made during the past year.

There is nothing of special importance to report upon at this time regarding the other projects of the department.

Respectfully submitted,

C. P. HALLIGAN,

Horticulturist.

East Lansing, Michigan, June 30th, 1920.

REPORT OF GRAHAM HORTICULTURAL EXPERIMENT STATION

Director R. S. Shaw.

Dear Sir: The work the past year at the Graham Horticultural Experiment Farm has consisted largely of removing old, dead peach orchards and fences, and of such other work incidental to the subduing of a general farm to a systematic plan for a public experimental station.

All of the available land for orchard planting, except a small area being reserved for a peach orchard, was set with young trees this spring including a block of Montmorency cherries, a block of a few varieties of sweet cherries, a block of Northern Spy apples, of Lombard plums, and of Bartlett pears for experimental projects.

Experiments were started to demonstrate the value of cover-crops and ascertain the best cover-crop to be used as measured by tree-growth and fruit-production.

A soil cultural experiment was started to compare the relative cost of

operation and the comparative effect on growth and fruit production of orchards handled on the soil-mulch system, the sod-mulch system, and where the trees are mulched with straw but planted to alfalfa instead of grass.

Another experiment has been started to ascertain the difference in the fertilizer requirements of trees growing on the above systems.

It is the desire of the department to do experimental work on bush fruits, grapes and vegetables and for such work it requires more room than is now available on the grounds. It strongly recommends the immediate purchase of the acreage bordering the west boundary of this property.

Mr. L. F. Waid, Superintendent of the Station grounds resigned on April 1st and has been succeeded by Mr. Donald H. Hootman, formerly of the Horticultural department at the College.

Respectfully submitted,

C. P. HALLIGAN,

Horticulturist.

East Lansing, Michigan, June 30th, 1920.

REPORT OF THE FARM CROPS SECTION.

Director R. S. Shaw, M. A. C.

Dear Director Shaw: I herewith present a brief report of the activities of the Farm crops section for the year 1919 and '20.

The use of more land on the Experiment Station farm through co-operative arrangement with the Farm and Horse department made possible a very considerable development in the scope and extent of the experimental work of the Farm Crops section. Forty-eight acres of land are now devoted to plant breeding work and 50 acres to general crops experiments and increases. The progress of the plant breeding work is reported in letter from Mr. F. A. Spragg, Research Associate, which is hereto appended. The major crops experiments along other lines at the Station and over the State are herewith reported:

1. *Corn Experiments.* The annual variety test at the Experiment Station was conducted as usual and supplemented by variety tests at sixteen well distributed points through the State. The results from variety tests, of past and former years, have enabled us to make a dependable map, showing the approximate regional adaption of corn varieties. The ear row work of the past year has enabled us to select six best remnants each from 85 ears of Duncan corn and 85 ears of Golden Glow. These remnant half ears were planted in carefully isolated increase plats, which should furnish us, this season, with improved strains of adapted Golden Glow and Duncan for multiplication and distribution, through the Michigan Crop Improvement Association. Similar ear row work was begun with Silver King and continued with Golden Glow and Duncan. Fourteen acres of land is occupied with the ear row work and variety tests at the Station. In addition, a test of popcorn varieties was begun. The popcorn industry has become of con-

siderable importance, in recent years, and there is a demand for information regarding best varieties and methods of handling this corn. Mr. J. R. Duncan is cooperating in handling the corn work.

2. *Forage Crops Experiments.* Comparative plantings of millets, Sudan grass, annual white sweet clover, soybeans, corn, peas and oats, oats and vetch, etc., was continued. A report of the first year's results of this work is included in this record. Professor C. R. Megee is cooperating in this work and other forage crop projects.

3. *Sweet Clover Experiments.* Three acres were planted to sweet clover for the purpose of forming a basis for experiments with time and rate of seeding, height of cutting, and handling sweet clover for hay and seed. A good catch has been secured. This experiment was begun under excellent conditions.

4. *Soybean Variety Test.* Variety tests with numerous soybeans, handled by Michigan seed firms and others, were conducted for the second season on the Experiment Station plats and over the State in variety tests.

5. *Comparative Tests of Foreign and Native Alfalfa and Clover.* With the appearance on the Michigan market of European clover and alfalfa seed, it was necessary to compare these varieties with native American and Michigan grown seed at the earliest opportunity. An experiment, including Italian, French, and Swedish clover seed and Italian, and Turkestan alfalfa seed and other varieties, as compared with American and Michigan grown clover and alfalfa seed, was planted in the spring.

6. *Over-State Experiments.* The formation of the Farm Bureaus in many Michigan counties has increased the demand for over-State cooperative experiments. In the past year twelve complete variety tests of oats, 16 of corn, 8 of soybeans and 4 of beans, were widely distributed over Michigan. This work is particularly valuable, in that it makes possible the distribution of varieties in accordance with adaptation.

7. *The Manitou Island Rosen Rye Project.* In order to insure the production of a supply of Rosen Rye of high purity, by increasing selected strains, where common rye can be eradicated and its introduction prevented, arrangements were made in the spring and summer of 1919 to introduce, on the South Manitou Island, selected strains of Rosen. The South Manitou was selected, after an investigation of Michigan shore islands by the writer, as being best suited. On September 12th, Mr. J. W. Nicolson was delegated to visit the island for the purpose of interesting the island farmers in adopting Rosen Rye as the standard rye of the island. Eleven farmers on the island took up the Rosen and, owing to the lateness of the arrival of the seed, the remainder made plantings of the island strain or Rosen secured from Traverse City. At the present time, the Rosen is showing up splendidly and those on the island have announced their intention of adopting it as the standard variety. The Michigan Crop Improvement Association has authorized the organization of an "Island order" to develop the highest type of Rosen possible. The work will be continued this year, based on selections made from isolated fields on the island, and next year pure strains will be introduced from the Experiment Station plats. The South Manitou Island should serve as a safe source of increase for the best type of

Rosen Rye, since its isolated position enables the growers to prevent the introduction of poor strains.

8. *Increase Plats on the Station Farm.* Wolverine, College Wonder, College Success, and Wisconsin Pedigree oats, and Smooth Awn barley, were planted in these plats varying in size from one acre to three acres and will furnish a considerable supply of seed through the Crop Improvement Association. In addition, five acres were given over to the annual white sweet clover, which should prove a promising crop for Michigan. It makes a vigorous growth and matures seed in a single season and gives promise of great value as a short season hay and pasture crop.

9. *Effect on Yield in Preparing Oat Land.* Since most of the Michigan oat crop is planted after corn, the point is often brought up as to whether corn land should be plowed or disced for the oat crop. Since a field of corn land was available for the Crops department, an experiment was planted in one-half acre plats, properly checked, two plats of one-half acre each being plowed in the fall, two one-half acre plats being plowed in the spring, and check plats and two additional plats being fitted by disc. All plats were planted on the same date to Wolverine oats. Apparently there is little noticeable difference to the eye at this date, in the yields from any of these treatments, but no definite conclusion can be drawn until after harvest.

The machinery now used by the department in plowing, planting, cultivating, harvesting and threshing is of the latest type, and was selected to replace older types after careful trials of several makes. The department is making use of tractors (secured from the Farm Mechanics department on a cooperative basis) for plowing, fitting land, handling manure, harvesting, and other operations except cultivating. Mr. C. W. Straight, field manager, has been largely responsible for placing the field work on a more efficient basis.

The Farm Crops section particularly appreciates the valuable co-operation of the Farm and Horse department and of the Farm Mechanics section.

Respectfully yours,

J. F. COX,
Farm Crops.

East Lansing, Michigan, June 30, 1920.

Professor J. F. Cox, M. A. C.

Dear Professor Cox: The purpose at this time is to outline the systematizing of the crops breeding work at M. A. C. by reciting some of the changes that have come about, giving details of the same since more land has been obtained and systems of crop rotation could be practiced.

Beginning with 1907 the crops breeding work had about eight acres in field No. 7 for spring crops and two acres north of the poultry plant.

In 1908 there were four two-acre fields south of the poultry plant, about three acres north of it, and a wheat variety series in field No. 6 or a total of fifteen acres.

In 1909 there were (besides the land around the poultry plant) about five acres of oats in field No. 6 and an equal amount devoted to a wheat series in field No. 15. This made about twenty acres in all.

In 1910, the oat series was moved to field No. 13. In the following

years up until 1917 one of the variety series usually found a place in some other farm field as No. 12, No. 14, or No. 16, but during all these years the breeding work had about 20 acres.

Throughout this time no rotation could be practiced because of uncertainty regarding land and because of the volume of the breeding work under-way. More land is now available for the plant breeding work—a five-year rotation on 5 five-acre fields in fields 9 and 10. The rotation is as follows: Beans, wheat, corn, oats, clover (turned under). In addition to this, however, there are eight acres in the back of field No. 9 that are being built up to take care of the flax breeding work in co-operation with the U. S. Department of Agriculture and the two acres north of the Poultry Plant devoted mostly to alfalfa breeding.

Most of the breeding work is carried on on the five five-acre fields to be cropped in rotation. This rotation is as follows, taking for example the front of field No. 10:

1918—Oats and barley seeded to clover.

1919—Clover plowed and seeded to fall wheat.

1920—Wheat and rye seeded to clover.

1921—Clover plowed under for beans.

1922—Corn, hemp, sunflowers and similar crops fall plowed.

1923—Oats and barley seeded to clover.

Thus the series will continue. The other four blocks will have the same rotation except so arranged that all of these crops may be planted in a single season.

In the present season (1920) there are 29 plats in the alfalfa variety series, and over 10,000 plants in the new alfalfa nursery, and about one and one-half acres in increase. There are 74 centgeners of barley, 138 plats in the barley variety series, and 19 plats in a rate of seeding test, on Michigan-2-Row, besides a plant-to-the-row barley series. There are 545 plats of beans. The clover nursery includes over 1,000 plants. There are 64 plats of corn, chiefly, selfing, increase and isolation plats. The hemp work includes two progenies that are planted in alternate rows for crossing. They are also used to separate the corns. There is no oat variety series for 1920, but the breeding work is ripe for a new variety series beginning with 1921. The new oats are in a row series that were plant-rows in 1919. The Rosen rye work includes rate and date of seeding and selected head isolation plat. The selfing work is in the investigational state. There are about 600 mother beets being selfed in an attempt to improve sugar beets by breeding.

During the two previous years there were test series on sunflowers, but only the best one is being increased from original seed in 1920. There are five acres devoted to an increase of the Hughes annual sweet clover. This is a promising new sort that should fill a needed place where the farmer has lost his clover seeding, and where grasshoppers are bad.

The timothy work continues in the form of seed plats and a variety series. There are 296 plats of wheat including centgeners, variety series, rate and time of seeding plats, and increases of six new wheats, originating in plant selections of 1915 and from crosses made in 1912. The problem is to produce wheats that have a stiff straw and at the same time are as winter hardy as the western hard winter wheats.

Respectfully submitted,

FRANK A. SPRAGG,

Plant Breeder.

REPORT OF THE SOILS SECTION.

Director R. S. Shaw:

This has been our most successful year. The field investigations of the soils of the State were vigorously pursued, there being in progress 35 cooperative projects in widely separated areas of the State. In addition fifty top dressing experiments were conducted in which nitrate of soda and ammonium sulfate were employed. The success of this work is due in no small degree to the enthusiasm, energy and judgment of G. M. Grantham and C. W. Simpson. These activities should be greatly extended and in fact our plans call for such.

The field investigations must be supported by laboratory studies. We are doing this. The physical studies of Bouyoucos on the solubility of minerals and soils, the moisture and temperature relationships, are far reaching in their importance. Comparison of cropped and virgin soils by Millar should be noted as well as the studies of Spurway on the effects of fertilizers on soils. Moreover I desire to bring to your attention the physical and chemical investigations of peat and muck soils that are in progress. Inasmuch as our knowledge of several of these phases is very meager we have considered it prudent to consider them.

Our cooperative agreement with the Bureau of Soils is satisfactory. Dr. C. F. Marbut assuming a very liberal and broad minded attitude. L. C. Wheeting capably acted in the capacity of State Leader in Berrien county. The reconnaissance survey undertaken several years ago has been continued with gratifying results.

Mr. Ezra Levin joined the section in the early spring and has assumed a proper attitude towards the organization. This transference should result in a unification and correlation of the peat and muck work in the State, in the absence of which maximum efficiency can not be obtained.

Respectfully submitted,

M. M. McCOOL,

Soil Physicist.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE FARM MECHANICS SECTION.

Director R. S. Shaw,
East Lansing, Michigan.

Dear Sir:—Following is a report of the experimental and investigational work of the Farm Mechanics section for the year 1919-20.

In the spring of 1919, five projects in experimental and investigational work were submitted. These projects included work on the cost of tractor operation, farm building plans, sewage disposal, drainage, and marl handling. On the first of these projects, cost of operating and practicability of the tractor for various kinds of work, some work has been done. In September, tests were run on ten tractors at the Centreville Fair, results of which were published in the November 1919 Quarterly. Mr. Sauve, started a scheme of record keeping in cooperation with owners of tractors in the spring of 1920. The results of this study will be available as soon as the season is over. Not as much time was devoted to this work as should have been, partly on account of summer school.

On the Farm Building study, Mr. Fogle spent considerable time in the field directing his efforts particularly to barn construction and arrangement. The results of this and previous study will be embodied in a manuscript to be submitted about January, 1921. Mr. Fogle also gave some time to cooperative association potato warehouses.

On none of the other lines of work has any considerable progress been made. Continued observations have been made on the septic tank, many of which are in use, some near the College.

Two lines of work have not been given the attention which they would seem to merit. Extension work in drainage in St. Clair county has opened a way for a somewhat more extensive study of the results of tile drainage as well as methods and costs. The cost of tile to Michigan farmers has become almost prohibitive due to the expensive factors of fuel, labor and transportation. If the Experiment Station could give assistance in increasing and improving Michigan's tile product, a great service would be rendered. The cost of lime has also increased greatly so that there is considerable demand for convenient and economical methods of excavating marl, which may be used as a substitute.

Respectfully submitted,

H. H. MUSSELMAN,
Farm Mechanics.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE FORESTRY SECTION.

Director R. S. Shaw.

Dear Director Shaw:—I herewith submit a brief report of the work of the Section of Forestry for the year ending June 30, 1920.

The experimental work in connection with the college sugar bush was continued, particular attention being paid to the relation between number of tap holes and yield of sap. More problems are arising in connection with this work, such as utilization of sugar sand, staining of the timber, etc., which are being taken up as rapidly as possible.

A study of the rate of growth in diameter, height and volume of forest plantations was begun during the year. This involved careful measurements of selected plantations, among them being the plantation established by Dr. Beal at Grayling. The study also involved the yield of nuts and cordwood from chestnut and black walnut plantations in the southern part of the State. Owing to the chestnut blight disease in the East which has destroyed or injured many of these trees in that region, Michigan growers have been obtaining a high price for the nuts, and there is much interest in nut tree plantations. Much valuable data was obtained in the course of this work and it is hoped to have a report ready this fall.

In connection with the forest nursery a considerable number of foreign trees have been introduced through the United States Department of Agriculture. A section of the nursery has been set aside as an experimental plot to study their requirements, hardiness and rate of growth. It is hoped to obtain a tree that will do well on sandy soil and that will grow rapidly, particularly with a view to the fixation of shifting sands.

The basket willow plantations that were established a few years ago near Spring Lake are being watched and give promise of success.

Respectfully submitted.

A. K. CHITTENDEN,

Forester.

East Lansing, Mich., June 30, 1920.

REPORT OF THE SECTION OF ANIMAL PATHOLOGY.

Director R. S. Shaw, College.

Dear Sir:—I submit herewith the report of the Animal Pathologist for the year ending June 30th, 1920.

A large part of my time has been devoted to a histo-pathological examination of the reproductive organs of sterile cows. This work was done in cooperation with the Department of Bacteriology, the latter department having made bacteriological examinations of the cases studied by the writer. This work pertains to a very important phase of the abortion problem, and is fundamental because of the fact that the most effective control measures cannot be worked out without a full knowledge of the nature of the disease. The results of this investigation may be found in a manuscript that constitutes a part of this report.

In addition to the above, considerable time has been given to a histological study of the effects of medicinal agents upon the reproductive organs of cattle. The usual treatment of sterility in cattle is more or less empirical and it is believed that our researches on the effects of medicinal agents on the reproductive organs will throw a great deal of light upon this important problem. This work is progressing satisfactorily and it is hoped that we will soon be able to present a manuscript covering it.

That our researches are bearing fruit is indicated by the fact that two weeks of the last year were spent by the writer in an adjacent state lecturing on the results of our researches at this Station and he also appeared on the program of several important meetings in this and two adjoining states.

Respectfully submitted,
E. T. HALLMAN,
Animal Pathologist.

East Lansing, Mich., June 30, 1920.

FURTHER STUDIES ON THE PATHOLOGY OF THE REPRODUCTIVE ORGANS IN STERILITY.

E. T. HALLMAN, ANIMAL PATHOLOGIST, MICHIGAN AGRICULTURAL EXPERIMENT STATION.

The cases referred to in this paper were obtained from four herds of cattle in which abortion disease has been a more or less serious problem for the last six or eight years.

The bacteriological investigations in connection with these cases were conducted by the Department of Bacteriology. To Dr. Bandeen is due the credit for the work on the first seven cases and to Dr. Stafseth for the work on the remaining four. An effort was made in each case to demonstrate the abortion bacillus. Cultural examinations and guinea pig inoculations were made from the surface of the uterine mucosa in the first seven cases and in the latter four cases, in addition to the above, material obtained from the deeper layers of the mucosa. After searing the surface with a hot iron, areas were selected which appeared pathologic and small pieces of tissue from the deeper layers were removed and ground in a mortar with sterile sand and physiological salt solution. Cultures and guinea pig inoculations were made from this material.

Not only were the guinea pigs subsequently killed and carefully autopsied but appropriate tissues were taken from the guinea pigs and tested culturally for *Bact. abortus* and their blood was tested with the complement fixation and agglutination test for *Bact. abortus* antibodies. All results were negative insofar as *Bact. abortus* was concerned.

Case 808 was purchased as a yearling September 7, 1917 at which time her blood was negative to abortion tests. September 23, 1917 twenty five cubic centimeters of live culture of *Bact. abortus* were injected subcutaneously. A positive reaction to the complement fixation and agglutination tests developed October 5, 1917, and her blood remained positive until the animal was killed.

This animal was bred first on November 1st, 1917 and on several occasions afterwards, but failed to conceive. Subsequent to February 22, 1918 the animal was more or less constantly in heat. An examination on March 12, 1918 demonstrated a muco-purulent discharge in vagina and a cystic left ovary. The cyst was crushed and the uterus douched but there is no record of what was used in uterus. There are no records of any subsequent treatment. Animal was slaughtered on August 9, 1918.

Macroscopic examination: Vagina contains a considerable quantity of clear mucus not unlike the mucus of estrum. External os closed. There is a small amount of adhesive mucus in cervical canal. Uterine body three and one half centimeters in length; mucosa contains no cotyledons; lumen small; wall apparently thickened and fibrous. Mucosa of horns yellowish gray and moist, cotyledons three to five millimeters in length and three millimeters in width. Oviducts apparently normal.

Right ovary two and one half centimeters in length and contains a cyst about the size of a hazel nut, left ovary, about two centimeters in length and shows a cicatrix extending around its dorsal border, transverse to the long axis of the ovary.

B. coli communior was obtained from cystic ovary. Cultures from uterms were negative.

Histological examination: The mucosa of the posterior cervix in places is covered by a stratified epithelium varying in thickness from sixty-five to one hundred thirty microns. The superficial cells show marked mucoid changes. Cyst-like structures averaging about twenty-five microns in diameter, containing a mucoid material are observed in the epithelium. A part of the mucosa of the posterior cervix is covered by a simple epithelium twenty to twenty-five microns high. Here there are numerous tubular depressions simulating wide, shallow glands. Practically all of the cells lining these tubules show mucoid changes.

The mucosa of the middle cervix shows the same extensive mucoid changes in the epithelium.

The structure of the wall of the uterine body is unlike that of the normal body but is similar to that of the anterior end of the cervix. At only one point is there seen a group of uterine glands (about forty in number) in the deeper portion of the stroma. All other portions show an absence of distinct uterine glands. The epithelium is arranged similarly to that of the anterior cervix and shows considerable mucoid changes though not as extensive as that of the cervix. The uterine wall is not differentiated into a distinct mucous membrane and a muscular coat but the muscularis blends with the stroma of the mucosa as is the case in the cervix.

The mucosa of the horns averages about three and one-half millimeters thick and is covered by an epithelium sixteen microns high. There are no epithelial defects. The tissue of the cotyledons extends from one to one and three-tenths millimeters into the stroma.

In the gland mucosa the subepithelial tissue is only very slightly more cellular and apparently more reticular than the more deeply lying stroma. There are about seventy-five cross cut gland tubuli per square millimeter, varying in diameter from forty to eighty microns. In a great many of the glands the epithelium is surrounded by a clear zone as if the glandular epithelium had contracted away from the periglandular tissue. For example, glands fifty microns in diameter are in a clear zone seventy five microns in diameter. A few goblet cells are present and numerous small round cells are seen in the lumen of some of the gland tubules.

Case 996 was born May 28th, 1916. On November 9, 1917, blood was positive to abortion test. On March 31, 1918, she gave birth to an apparently normal calf after a prolonged labor. A few days after this a vaginal discharge was observed and examination demonstrated considerable pus in uterms. Uterms was douched daily for three weeks with a weak solution of a coal tar disinfectant. During the last week of treatment an ulcerated cervix was treated by swabbing at intervals of two days with 50 per cent tincture of iodine in glycerine, four treatments being given. The animal apparently recovered. At the beginning of this treatment *Streptococcus pyogenes* and *Bacillus pyogenes* were isolated from the uterms. During the latter part of July endometritis again

developed. At this time *Streptococcus pyogenes* and *B. coli communior* were isolated from the uterus. The uterine discharge was of a reddish brown color and fetid odor. She was given the same treatment indicated above and the uterine discharges ceased but there soon developed a peri-uterine abscess. She was slaughtered October 7, 1918.

Macroscopic examination: There is an abscess containing about one hundred cubic centimeters of thick creamy pus slightly to the right of median line and between uterine body and rectum. The capsule wall has involved the dorsal wall of vagina and uterus and ventral wall of rectum so that rectum is dissected from vagina and uterine body with difficulty. Externally, the left oviduct is apparently normal. The ovarian end of right oviduct is involved in the abscess capsule. The left ovary is covered by peritoneum and shows a few immature follicles on surface. The right ovary is completely ensheathed in fibrous tissue that is a continuation of the abscess capsule. There are several small abscesses in the broad ligament containing a thick creamy pus, and varying in size up to as large as a hazelnut.

The cervical canal is five and one-half centimeters in length, mucosa apparently normal. Uterine body is two centimeters in length. Uterine cavity contains no excessive exudate and mucosa is moist and glistening. It is of a grayish chocolate color but not entirely uniform; around some of the cotyledons it is apparently more vascular. The cotyledons vary in size from three to six millimeters in diameter and those of the left horn are apparently more vascular.

Historical examination: The mucosa of the external cervix is covered in places by an epithelium twenty-five microns thick and four cells deep. In other places it is covered by simple epithelium and only six microns in depth. Whether this is the result of incomplete development of the epithelium subsequent to cervicitis is a question. There are no other epithelial defects. There is no subepithelial cellular zone. The mucosa of the middle and anterior cervix is covered in places by an epithelium thirty-five microns deep and consisting of four layers of cells. In other places the epithelium is simple and fifteen microns deep. There are no epithelial defects. In a few places there is a subepithelial zone about fifty microns deep that is slightly more cellular than the deeper part of the stroma. Otherwise there is no differentiation between a cellular subepithelial zone and a deeper fibrous layer. At one point about one hundred fifty microns below the surface is an area of cells about one-hundred twenty-five microns in diameter. These are apparently connective tissue cells in the transitional stage between fibroblasts and fixed connective tissue cells.

The mucosa of the uterine body varies in thickness from six-tenths to one and one-half millimeters. It is covered by a simple epithelium averaging about fifteen microns high. Only a few mucoid cells are seen. A differentiation into an outer cellular and an inner more loosely fibrous layer of the stroma is not distinct. The deeper portion of the stroma is more densely fibrous than is the corresponding part of the normal wall. There is a conspicuous diminution in the number of uterine glands. In some portions of the gland mucosa no glands are observed. The uterine glands vary in diameter from twenty-five to forty microns.

The mucosa of left horn varies in thickness from one to three millimeters, averaging a little thicker toward the middle and anterior end of the horn. The epithelium is simple and averages about twenty microns

high. There are no epithelial defects. The outer cellular layer of the stroma is not uniform but in places the more fibrous deeper portion extends to the epithelium. A few small foci of small round cells are seen in the deeper portions of the stroma. These foci vary in size from one hundred twenty-five to one hundred seventy-five microns in diameter. They consist of cells which apparently represent an intermediate stage between fibroblasts and fixed connective tissue cells. The diminution in number of glands is not as marked as in the uterine body. The mucosa of the right horn shows the same changes seen in the left horn. In addition some of the gland luminae contain a few lymphocytes and there are a few local areas of edema in the stroma.

Case 17. Red Poll heifer three years old, was bred for the first time in April, 1918, and was soon turned on pasture for the summer. During the first week in December, 1918, she aborted a four months' old fetus. This was apparently from service in pasture during the summer. Animal was killed for beef January 21, 1919.

Macroscopic examination: Uterus not enlarged, oviducts apparently normal. Left ovary contains a corpus luteum about one and one-half centimeters in diameter, also one cyst-like structure one centimeter in diameter and several immature follicles slightly protruding above surface. Right ovary normal.

External cervix is two and one-half centimeters in diameter, external os is closed. There is a small quantity of a turbid slightly adhesive exudate in external os. There is some hypertrophy of the second and third transverse folds of the cervical mucosa. Uterine body is four centimeters in length. Mucosa has a fairly uniform light drab color. Mucosa of right horn not uniform in color. Portions of the gland mucosa are of a light drab color, others dark drab, giving the gland mucosa a mottled appearance. The mucosa is moist and glistening but there is no excessive exudate. The cotyledons are three to six millimeters in length and of uniform color. Mucosa of left horn is of a lighter and more uniform color. Cultures from uterine horns were negative.

Histological examination: The mucosa of the external cervix is covered by a simple epithelium fifteen to twenty-five microns high. The sub-epithelial tissue is very slightly, if any, more cellular than the deeper lying stroma. There is considerable mucus between the folds of mucous membrane and in the tube-like depressions in which are seen numerous lymphocytes. The epithelial cells show considerable mucoid changes but not to the same extent as is seen in case 808. It is apparent that in this case (17) the nuclear changes are not the same as in case 808. Here the nucleus is larger, more vesicular and more deeply stained than in case 808. The questions arise: Is there a distinction between physiological mucus production and that seen in the catarrhal conditions? Are the latter characterized more particularly by degenerative nuclear changes?

The mucosa of the middle cervix differs from that of the external cervix only in that here the rugae and tubular depressions are more numerous and the stroma in places is slightly more cellular. In a few of the spaces between the folds are numerous exfoliated epithelial cells. In the mucosa of the anterior cervix the mucoid changes are less conspicuous and the sub-epithelial tissue is more cellular. Near the apex of some of

the rugae the fibroblasts are so numerous that the structure simulates that of the cotyledon of the non-pregnant uterus.

The mucosa of the uterine body averages about one and eight-tenths millimeter in thickness and is covered by an epithelium sixteen to twenty-five microns high. There are no epithelial defects other than a few lymphocytes are seen passing through the membrane. There is a fairly uniform cellular sub-epithelial stratum averaging about three-tenths millimeter in depth in which moderately numerous eosinophiles are seen. A few groups of glands are seen where the periglandular tissue consist almost entirely of fibroblasts. The glandular epithelium in these groups show no defects.

The mucosa of the right horn averages about two millimeters thick and is covered by an epithelium twenty to twenty-five microns high.

There are no epithelial defects except that in places numerous lymphocytes are seen passing through. There is a distinct sub-epithelial cellular zone which in places show considerable blood pigment and numerous small round cells and eosinophiles. The latter are more numerous. There are a few foci averaging about one hundred microns in diameter in which eosinophiles are the predominating cells. One focus of polymorphonuclears and fibroblasts is seen. There are a few groups of glands in the deeper layers of the mucous membrane which show a slight peri-glandular fibrosis. There are no defects of the glandular epithelium though in the lumen of a few glands are seen numerous lymphocytes.

The mucosa of the left horn averages about two millimeters thick and is covered by an epithelium sixteen to twenty-five microns high. There is a fairly uniform sub-epithelial cellular zone averaging about two-tenths millimeter deep. There are no defects of the glands although there is a slight peri-glandular fibrosis in a few places. At one point involving an artery with a lumen of one hundred forty microns and a wall eighty microns thick there is a crescent shaped area of what appears to be transitional fibroblasts that extends about one-third the distance around the artery. At one point this area involves about one-half the thickness of the arterial wall. At its thickest portion it is ninety microns and gradually diminishes to a point at each end.

Case 18 is a Holstein cow five and one-half years old. She was bred for the first time August 20, 1914, and calved May 21, 1915. After this she was bred unsuccessfully a number of times and was treated for sterility but records do not show nature of treatment. She was then bred January 27, 1916, and calved October 28, 1916. The records show the following service dates: September 17, 1917; January 3, 1918; February 14, 1918; March 10, 1918; August 8, 1918. There were no known abortions during this time. The animal was slaughtered January 27, 1919.

Macroscopic examination: There is a cyst four centimeters in length and one and one-fourth centimeters in diameter projecting above surface of floor of vagina ten centimeters posterior to external os. Cervical canal contains a small quantity of clear, slightly adhesive exudate. The posterior transverse fold of cervical mucosa is considerably enlarged in its lower portion. The left lateral portion of third fold is also enlarged but not to the same extent as is the posterior fold. Body of uterus two centimeters in length, mucosa fairly uniform in color. Mucosa of left horn is of a light chocolate color though some portions show a little more blood pigment than others. Cotyledons are normal in appearance. The

gland mucosa around cotyledons in right horn is a little more vascular than usual. Both oviducts are apparently normal. Right ovary contains a corpus luteum one and one-half centimeters in diameter in the center of which is a cyst six millimeters in diameter. Left ovary contains a cyst-like structure one centimeter in diameter. Cultures from the uterus and ovaries were negative.

Histological examination: Other than slight mucoid changes in the cervical epithelium and a fibrous thickening of the transverse cervical folds, no histological changes could be detected in the uterine mucosa.

Case 20. Grade Shorthorn about six years old. Her last calf was born in January, 1917. She was bred during the late spring or early summer of 1917 and was thought to be with calf. There was no known abortion but during the spring of 1918 she began to come in heat first irregularly, but later, during the summer and fall, quite regularly. She has been bred persistently with failure to conceive. She was slaughtered February 11, 1919.

Macroscopic examination: External cervix is three centimeters in diameter. External os closed. There is a considerable quantity of clear, only slightly adhesive exudate in external os and covering posterior end of cervix. Cervical canal is six and one-half centimeters in length. Transverse folds of mucous membrane are normal but there is an appreciable quantity of rather adhesive exudate in canal. Body of uterus is four and one-half centimeters in length. Mucosa is of a light gray uniform color. Cotyledons three millimeters in diameter. Mucosa of horns similar to that of uterine body with an occasional more slightly vascular area. The color of the mucosa is more like that of a heifer's uterus than that of a cow's that has calved. Both oviducts are apparently normal. Left ovary is four centimeters in diameter, spherical in shape and has a protruding corpus luteum two centimeters in diameter. Right ovary is four centimeters in diameter, and has one cyst two centimeters in diameter and several smaller ones. Cultures from uterus were negative. *B. Coli communior* was isolated from cystic ovary.

Histological examination: Only slight mucoid changes are observed in the cervical epithelium. Otherwise the cervical mucosa is normal. In the mucosa of the uterine body, the sub-epithelial cellular layer is not uniform but in places is indistinct. There is apparently but little fibrosis but some local edema. A few foci of small round cells are seen in the mucosa. There are no glandular changes. The mucosa of the horns does not differ from that of the uterine body.

Case 21. Guernsey cow, born May 16, 1911. Records show following service dates: February 27, 1913; March 30, 1913; December 20, 1913; January 12, 1914; February 3, 1914; March 10, 1914; March 30, 1914; April 10, 1914; April 27, 1914; May 5, 1914; May 27, 1914; June 30, 1914; August 9, 1914. Calved May 15, 1915. There is no record of abortion nor do the records show the appearance of heat between March 30, 1913, and December 20, 1913. Artificial impregnation was attempted by the manager at heat periods from December 20, 1913 to May 5, 1914, inclusive (included in service dates above), and the yeast treatment was given by him on June 30, 1914, and August 9, 1914. After calving the following service records are recorded: July 20, 1915; September 9, 1915; September 18, 1915; October 4, 1915; October 21, 1915; December 21, 1915; December 31, 1915; January 20, 1916; February 24, 1916;

March 31, 1916; May 19, 1916; June 7, 1916; June 23, 1916; July 11, 1916; September 9, 1916; October 12, 1916; November 8, 1916; January 20, 1917; September 22, 1917; December 6, 1917; March 25, 1918. The yeast treatment was given at heat periods from March 31, 1916, to June 23, 1916, inclusive. On November 8, vagina was douched with warm salt solution before service and on September 22, 1917, soda solution was used in vagina before service. Sometime during the spring of 1918 (date not recorded) the writer made an examination and diagnosed pregnancy, apparently of about seventy or eighty days duration. A few weeks later another examination was made by the writer at which time there was no evidence of pregnancy. No record was made of the clinical condition at this time. She was shortly turned out to pasture without further service to bull and remained in the pasture until October 12, on this date the following notes were made by the writer: There is a small quantity of clear mucus in vagina in which are seen a few flakes of pus. On manipulation of cervix fifteen or twenty cubic centimeters of a more adhesive drab colored exudate is forced out of cervical canal. The external os and posterior end of cervix is sufficiently dilated to allow the insertion of three fingers although the canal is closed at its anterior end. On rectal examination it is found that the uterus is distended. The walls are tense and simulate pregnancy of the fourth or fifth month although a fetus cannot be felt. The writer is informed that the cow was not bred subsequent to his last examination the previous spring and no bull had been with cow in pasture during the summer. The writer then proceeds to draw some fourteen to sixteen liters of amniotic fluid from the uterus after which a twenty-five to thirty centimeter fetus can be distinctly felt through the rectum. No effort was made to remove the fetus at this time, believing that it would be delivered in a few days. On November 8th this animal was again examined and the following notes made: The fetus has been delivered. Uterus is still somewhat enlarged but there is no apparent discharge. On December 14th an examination revealed an adhesive muco-purulent discharge in anterior part of vagina and cervical canal. No enlargement of uterus, tone fair, small cyst in right ovary. Cyst was crushed and cervix cleansed and swabbed with Lugol's solution of iodine and thirty cubic centimeters of a fifty per cent Lugol's solution was injected into the uterus. The writer did not see the case again until February 1st, 1919, at which time there was a muco-purulent discharge in vagina. External cervix was congested and canal open. Uterus not enlarged and tone fair. The owner did not care to attempt further treatment and animal was slaughtered February 11, 1919.

Macroscopic examination: External os is dilated, cervical canal is nine centimeters long and contains a small quantity of a clear, slightly adhesive, exudate. There is a slight hypertrophy of the first transverse fold of mucus membrane in its lower and right lateral portion. The mucosa is of a light drab color. Body of uterus two centimeters in length, mucosa of a slightly mottled light pinkish color. Small areas of a lighter grayish color are seen. Mucosa of posterior end of left horn is similar in appearance to that of the body. Cotyledons are three millimeters in diameter and are of a grayish white color, contrasting with gland mucosa. In proximity to one cotyledon near posterior end of

horn is a small nodule one centimeter in diameter and projecting about six millimeters above surface of mucosa, which appears to be a small tumor. The mucosa of the middle and anterior portions of left horn is of a light drab but not uniform, color; there is present a small quantity of a turbid creamy exudate. The mucosa of the right horn is more uniform and a lighter drab color than that of left horn. The same exudate as seen in left horn is present. A small piece of flat bone, four and one-half centimeters long by one and one-fourth centimeters wide is found lying free in anterior end of horn. There is a cyst one centimeter in diameter at the fenestrum of right oviduct. Left oviduct apparently normal. Right ovary is four by four and one-half centimeters and has a cyst two centimeters in diameter. The left ovary is four by five and one-half centimeters and has a cystic corpus luteum four centimeters in diameter. *B. coli communior* was isolated from the uterus. Cultures from cystic ovaries were negative.

Histological examination: The mucosa of the posterior cervix is covered in places by a simple epithelium twenty to twenty-five microns high and in others by a stratified epithelium, six to eight cells deep, and sixty-five microns high. The mucoid changes of the epithelium are well marked. A faintly pinkish granular exudate containing many small round cells is adherent to the surface in places. The sub-epithelial tissue is but slightly cellular. In the middle and anterior portions of the cervix, the mucoid changes of the epithelium are more extensive than in the posterior end. Here the nuclei show distinct degenerative changes. The sub-epithelial zone is distinctly cellular and shows many small round cells and polymorphonuclears. The mucosa of the uterine body averages about two millimeters thick. The sub-epithelial cellular zone is not uniform but is absent in places. The deeper portions of the gland mucosa are not uniform. In places there is an absence of glands and the stroma is edematous. The glandless areas are not densely fibrous but are more reticular with here and there small areas of a more fibrous nature. In the glandular portion of the stroma the periglandular tissue is more cellular than is normally seen. There are no defects of the glandular epithelium but in a few of the gland tubules numerous small round cells are seen.

The mucosa of the left horn varies in thickness from three to six millimeters and is covered by an epithelium sixteen to twenty-five microns in height. There are no epithelial defects. There is not a uniform sub-epithelial zone with a deeper more reticular stroma but the deeper stroma is distinctly denser because of an increase of the cellular and fibrous constituents. There is considerable infiltration of the sub-epithelial tissue with small round cells and an increase in the number of connective tissue cells. However, the small round cell infiltration is not uniform and in places it has the appearance of irregularly shaped follicles. The small tumor in the posterior end of horn described in the macroscopic examination consists of a cheesy pinkish staining material with a few nuclei scattered throughout the cheesy material. The wall surrounding this mass is lined with low cuboidal epithelium, indicating that the nodule is due to the plugging of a gland duct with retention and inspissation of the secretions. A few of the gland tubules show some disintegration of the epithelium with numerous small round cells in the

lumen but the majority of glands show no epithelial defects. Many of the gland tubules show a peri-glandular fibrosis though this has not reached the stage of scar tissue. A few localized areas of edema are observed in the stroma. In the region of a cotyledon there is a distinct depression in the mucosa but this does not appear to be due to cicatrization but to a vitreous degeneration and obliteration of the underlying arteries.

The mucosa of the right horn varies in thickness from three to seven microns and is covered by an epithelium sixteen to twenty-five microns high. In places there is a small amount of exudate consisting of red blood cells and leucocytes adherent to the surface of the epithelium. There is also seen in places a layer of a granular pinkish material containing a few leucocytes between the epithelium and sub-epithelial cellular zone. This layer is fifteen to thirty microns thick. There are no marked epithelial defects except in places there is a separation of the epithelial cells through which the granular layer above described is continuous with the surface coagulum. The sub-epithelial cellular zone is not uniform in depth but in places extends down into the stroma and reaches the muscularis in places. There is seen here the same small round cell infiltration and peri-glandular fibrosis as described in the left horn. Adjacent to an arteriole forty microns in diameter is a focus of fibroblasts about one hundred microns in diameter. There is some disintegration of the glandular epithelium and small round cell infiltration observed in a few of the gland tubules.

Case 22. Guernsey cow born August 30, 1910. First served December 21, 1912, and calved normally October 2nd, 1913. Was again bred April 18, 1914, and calved normally February 1, 1915. Was then bred March 16, 1915, and aborted May 30, 1915. She was successively bred August 22, 1915; October 26, 1915; December 10, 1915; April 2, 1916; and aborted November 4, 1916. She was then bred January 12, 1917; February 2, 1917; February 26, 1917; March 18, 1917; April 9, 1917; May 6, 1917 and November 6, 1917. Abortion was not observed between May and November. There is no record of the case between November 6, 1917, and December 14, 1918, other than that there has been no known abortion nor has the cow calved during that time. On December 14, 1918, the following notes were recorded: There is some cloudy mucus around external os. External cervix much congested, canal slightly dilated. Uterus not enlarged but walls are flaccid. The cow was slaughtered on February 11, 1919.

Macroscopic examination: The external cervix is four and one-half centimeters in diameter. The external os is slightly dilated and there is present a considerable amount of slightly cloudy adhesive exudate. The cervical canal is eight centimeters in length, mucosa of a grayish drab color with a few ecchymotic areas. Body of uterus five centimeters in length, mucosa of a darker drab and more uniform color than that of the cervix. The mucosa of the horns similar to that of the body with a few small areas apparently more vascular. Cotyledons are six millimeters in diameter and of a yellowish gray color. There is a protruding corpus luteum about six millimeters in diameter in each ovary, also a cyst-like structure in left ovary about one and one-half centimeters in diameter. Right ovary is spherical and two and one-half centimeters in diameter. Left ovary is three by two centimeters in size. Cultures from uterine were negative.

Histological examination: The mucosa of the external cervix is covered in some places by a stratified epithelium sixty microns deep and in others the epithelium is simple and twenty-five microns high. The exudate has been washed off except between the folds of mucous membrane; here it appears as a partly granular, partly stringy, pinkish mass in which many lymphocytes are seen. The epithelial defects are not marked though in places there is some mucoid degeneration. The sub-epithelial tissue is quite generally fibrous with here and there slight accumulations of leucocytes. It is observed however, that in the region of the fundus of the pits between the folds of mucous membrane the sub-epithelial tissue is more cellular. Whether this is due to greater irritation due to retarded drainage of the exudate is a question. The mucosa of the middle and anterior cervix is covered by a simple epithelium twelve to twenty-five microns high. Mucoid degeneration of the epithelium is marked. There are observed in the stroma a few foci of fibroblasts averaging about two hundred microns in diameter. These are at an average depth of five-tenths millimeter from the surface. The mucosa of the uterine body is five to six millimeters in thickness and is covered by an epithelium twenty-five to forty-five microns high apparently consisting of four or five layers of cells in places. There are no marked epithelial defects though in places numerous lymphocytes are seen in the process of passing through the epithelium. The sub-epithelial cellular zone is not distinct but considerably more fibrous than in the normal uterus. Many fibroblasts and distinct foci of fibroblasts are seen in the stroma. The deeper portions of the stroma are more densely fibrous than normal though the increased thickness of mucosa is partly due to edema. There is a marked diminution in the number of glands. The glands are not uniformly distributed but are completely absent in places; only a few of the glands show mucoid changes in the epithelium. The mucosa of the left horn varies in thickness from one and six-tenths to nine millimeters. In the thicker portions considerable edema with leucocytic infiltration is observed. A differentiation into an outer and inner layer of the stroma is not uniform. The sub-epithelial zone is more fibrous than normal with distinct cicatrization in places. The uterine glands are more uniformly distributed than in the body but more mucoid changes with some disintegration of the glandular epithelium are observed. The mucosa of the right horn varies in thickness from four to ten millimeters and is covered by simple epithelium twenty to twenty-five microns high. There are no marked epithelial defects though a few leucocytes are seen passing through the membrane. The stroma is not uniformly differentiated into two layers but there is a fibrosis of both layers. Much edema of the stroma is observed although the amount varies considerably in different portions of the mucosa. Numerous eosinophiles and lymphocytes are seen in the edematous areas. Scattered through the edematous areas are seen groups of from one to four gland tubules with occasionally an arteriole surrounded by a fibrous peri-glandular tissue. These groups which are irregularly shaped and vary in size from one hundred twenty to seven hundred fifty microns in their greatest diameter, stand out as islands surrounded by edematous fluid. The glandular defects are not marked though there are slight mucoid changes in the glandular epithelium and the peri-glandular tissue is distinctly, though not densely, thickened. Only occasionally are there

observed a few glands with atrophic epithelium and surrounded by scar tissue. Here desquamated epithelium and leucocytes are observed in the gland luminae.

Case 23. Guernsey cow, past breeding record not available but it is known that animal has had two or three calves and has been bred a number of times since calving with failure to conceive. On January 20, 1919, it was recorded that the external cervix was very much congested but no abnormalities of the uterus or ovaries could be detected by rectal examination. On the above date the cervix was swabbed with Engol's solution of iodine. This animal was slaughtered March 3, 1919.

Macroscopic examination: There is a small quantity of a rather adhesive muco-purulent exudate in the anterior part of vagina and external os. There is some hypertrophy of the external fold of mucous membrane of the cervix in its lower right portion. The mucosa is not of a uniform color but the lack of uniformity is apparently due to some portions being more vascular than others. At the lower border of middle transverse fold there is a fibrous tag adherent at each end to fold leaving a small opening beneath tag. The mucosa of the anterior cervix is adherent completely closing cervical canal. The adhesions are not dense but apparently of recent origin. This condition is probably a sequel of the treatment administered on January 20. The body of uterus is five centimeters in length and the wall of body and left horn is much thinner than normal and suggests the condition of pregnancy. The left horn contains about one hundred twenty-five cubic centimeters of serous exudate but no coagulum is present. The mucosa is of a light drab but not uniform color. In some portions the vascular network is distinctly seen indicating considerable thinning of the overlying mucosa. The cotyledons average about three millimeters in diameter and are gray in color. The wall of right horn is thicker than that of body and left horn but there is some thinning of this wall. Mucosa similar to that of left horn. Both oviducts are apparently normal. Right ovary spherical, two and one-half centimeters in diameter, contains a cyst-like structure one centimeter in diameter and several regressed corpora lutea. Left ovary is oval and is four and one-half centimeters in its longest diameter and contains a cyst two and one-half centimeters in diameter. Staph. pyogenes aureus, and Staph. pyogenes albus were obtained from the surface of mucous membrane and were also obtained from the deeper layers.

Histological examination: No tissue is saved from the cervix and uterine body. The Mucosa of the left horn varies in thickness from thirty-six one hundredths to eight-tenths of a millimeter, (the uterine wall is only two or four millimeters thick) and is covered by a simple epithelium twenty-five microns high. The stroma of the mucosa is not differentiated into two layers but is more densely fibrous than normal. The proportion of glands to interglandular tissue is apparently normal. A few of the glands show cellular degeneration with numerous lymphocytes in the gland luminae. Atrophy of the muscle fibers of the internal muscular coat is apparent. The mucosa of the right horn varies in thickness from one and one-half to four millimeters and is covered by an epithelium eighteen to thirty microns high. In places a few vacuoles and disintegrating cells are observed in the epithelium. The sub-epithelial cellular zone is more noticeable than in the left horn. The center of one cotyledon is depressed and appears to have undergone

some induration to a depth of one hundred fifty microns. In another cotyledon there is a more deeply seated indurated area about one millimeter in diameter. Beneath this cotyledon are numerous glands with atrophic epithelium. The condition of stroma varies in different parts of horn. While there is a more or less uniform diffuse fibrosis of the stroma the stage of fibrosis varies in different portions. In places the inter-glandular tissue is largely fibrous, in others it consists very largely of fibroblasts indicating an active condition. Numerous small round cell foci averaging about two hundred fifty microns in diameter, are seen both in the gland mucosa and region of the cotyledons. The condition of the glands varies considerably in different portions of the horn. In places the glandular epithelium is apparently normal, in others there is shrinking of the nucleus and caryorrhexis with disintegration of the cytoplasm. Here numerous small round cells are seen, in the gland luminae.

In this case and the remaining three of this series, an attempt was made to stain sections from different portions of the uterus for bacteria but we were not able to successfully demonstrate their presence. In some of the sections a few scattered small spherical bodies were seen but these were not sufficiently numerous to determine whether they were cocci or chromidia. In view of the fact that cultures were obtained from the deeper layers of the mucosa it is believed that our technique was imperfect or else there were such small numbers of bacteria that they were not recognized.

Case 24. Guernsey cow about five years old. This cow aborted a seven months old fetus in September, 1917. A few days afterwards three fetal hoofs were washed out of uterus. She soon made an apparent recovery and was bred persistently with failure to conceive. February 1, 1919, the author made an examination of the cow and recorded that vagina contains no excessive exudate. There is a little enlargement of the right horn, and right ovary contains a corpus luteum. Animal is probably pregnant but not sufficiently advanced to make a positive diagnosis. February 22, an examination by author found the animal not pregnant but the clinical condition was not recorded. She was slaughtered March 2, 1919.

Macroscopic examination: The external os is slightly dilated. The cervical canal is seven and one-half centimeters in length. There is an excess of clear mucus in canal. First transverse fold of mucosa and mucosa of anterior cervix shows quite a few petechial hemorrhages. Uterine body two and one-half centimeters in length, mucosa of a fairly uniform light drab color. Mucosa of left horn of a light drab color. The cotyledons are not numerous and those that are present appear as a very small slightly elevated grayish area with a depressed center. Mucosa of right horn of a fairly uniform light chocolate color. Only few cotyledons visible. Near posterior end of horn is a scar-like area, grayish white in color, irregularly triangular in shape, two and one-half centimeters in length and six millimeters at base. In the anterior end of horn there are a few hemorrhagic or acutely congested areas at the crest of the folds of mucous membrane; these areas average about six by twelve millimeters in size. Both oviducts apparently normal. Left ovary is three centimeters in diameter and contains a protruding corpus luteum one centimeter in diameter. Right ovary is oval, is four centi-

meters in its longest diameter and contains a cyst-like structure one centimeter in diameter. A micrococcus and *B. subtilis* were obtained from the surface and also deeper layers of uterine mucosa.

Histological examination: Sections are saved only from posterior cervix and right uterine horn. No abnormalities are observed in the external cervix. The mucosa of right horn varies in thickness from three to five millimeters and is covered by an epithelium averaging about twenty five microns in height. The subepithelial cellular zone is fairly well marked though in places apparently extends to a greater depth into the stroma than is normally seen. Numerous lymphocytes are diffusely scattered through the stroma and in places foci of small round cells are seen. There is marked edema of the stroma and here and there evidence of proliferation of the interglandular tissue. The glandular changes are conspicuous and extensive. They vary from vacuolization of only a few cells in a gland tubule to very marked caryorrhexis with disintegration of the cytoplasm and marked round cell infiltration of the gland luminae. Many of the coiled uterine glands show cicatrization.

Case 25. Guernsey cow about seven years old. As a heifer this animal was bred persistently before she conceived and calved apparently normally during the summer of 1915. She was again bred the following December and calved in September, 1916. For the next year and a half she was bred irregularly but never conceived; at least abortion was not observed during that time. She was treated once during the summer of 1918, and again once during the fall for a cystic right ovary. There is no record of the nature of treatment. February 1, 1919, the author examined this cow and made the following notes: There is considerable mucopurulent discharge in anterior vagina. External os is slightly dilated, mucosa is moist and congested but no apparent hypertrophy of external cervix. Uterus not enlarged, walls somewhat flaccid. Right ovary contains a cyst. The cyst was dislodged, uterus massaged and cervix swabbed with Lugol's solution of iodine. February 22, animal was examined by the author and the following notes recorded. There are about one hundred cubic centimeters of cloudy mucus in anterior vagina and external os. The external os is open and the mucosa slightly congested. Uterus not enlarged, walls flaccid. No cyst can be felt in either ovary. The uterus and ovaries were massaged and cervix swabbed with Lugol's solution of iodine. March 22, the following notes were made by the author: There are about thirty cubic centimeters of a slightly adhesive exudate in anterior part of vagina. The mucosa of cervix is slightly congested and there are a few friable adhesions in the posterior cervical canal. The left uterine horn is somewhat smaller than right, the wall is flaccid and noticeably thinner than that of right horn. There is a cyst the size of a hazelnut in left ovary. No cyst can be felt in right ovary. No treatment was given at this time as an unfavorable prognosis was made and the animal was slaughtered March 23, 1919.

Macroscopic examination: There is an excess of clear mucus in anterior part of vagina and external os. Cervical canal is seven and one-half centimeters in length and contains a small quantity of a clear mucus in which a few flakes of pus are seen. The mucosa is not uniform in color but shows a few injected areas. There is some hypertrophy of the right lateral portion of the second transverse fold with a small fibrous tag attaching apex of this fold to opposite wall of cervix. Body of uterus

is four centimeters in length, and the wall is abnormally thin. The mucosa is mottled, of a grayer color than normal and in places the underlying vascular network can be easily seen. No cotyledons can be seen. The mucosa of left horn is similar in appearance to that of body only here a few cotyledons are present varying in size from three to six millimeters in diameter. The thinning of the wall of this horn is very noticeable. Externally, the size of horn is apparently one-half that of right. There is a small quantity of a flocculent serous fluid in right horn. The mucosa is of a grayer color than normal and the cotyledons are six to nine millimeters in size. Their color is a mottled grayish yellow and simulate the appearance of a cotyledon in the latter stages of involution. Near the middle of right horn is an area about five centimeters in diameter, the wall of which is not more than three millimeters thick. In the center of this area is a radiating scar. The left ovary contains four cysts the largest of which is about two and one-half centimeters in diameter. The right ovary contains two cysts, the larger of which is about two centimeters in diameter. Cultures from the surface of uterine mucosa were sterile. *B. coli communior* was obtained from the deeper layers.

Histological examination: The mucosa of uterine body varies in thickness from three-tenths to eight-tenths of a millimeter and is covered by an epithelium averaging about sixteen microns in height. The sub-epithelial cellular zone is not distinct and the entire stroma is more densely fibrous than normal. The ratio of glands to interglandular tissue is apparently normal. A few of the more deeply seated glands show atrophic epithelium and there are others that show some degenerative changes of the epithelium with small round cell infiltration of the gland luminae. The mucosa of the left horn varies in thickness from five-tenths to one and one-fourth millimeters and is covered by an epithelium twelve to sixteen microns high. The uterine wall varies from two to ten millimeters in thickness. Fibrosis of the stroma is more or less general but varies in extent in different portions. At places it is slight in others it is marked and has resulted in atrophic thinning of the mucosa. The condition of the uterine glands also varies. In some places they are apparently normal, in others there are degenerative changes of the glandular epithelium with small round cell infiltration and in still others there are glands with atrophic epithelium. The mucosa of the right horn varies in thickness from eight tenths to two millimeters. The glandular changes are similar to those of the left horn. There is a more or less general fibrosis of the stroma but not to the extent seen in the left horn.

Case 26. Guernsey cow about eight years old. As a heifer she was bred several times before conceiving and calved normally in the spring of 1911. Her second calf was aborted at about four months in the fall of 1911. She calved normally again in the fall of 1915 and has been bred irregularly since then with failure to conceive, at least abortion has not been observed. Cow was slaughtered March 23, 1919.

Macroscopic examination: There is a yellowish mucopurulent exudate in vagina and external os. In the floor of the vagina there is a multilocular cyst five centimeters long, one and one-half centimeters wide by six millimeters high. Externally, there is no enlargement of the uterus. The external os is closed, cervical canal nine centimeters in length. The

transverse folds of the mucosa are congested and there is some hypertrophy of the left lateral portion of the second fold. Body of uterus is four centimeters in length. There are about thirty cubic centimeters of a sero-purulent exudate in uterine cavity. The mucosa of body is not uniform in color. Upon close examination, areas are seen in which there are small irregularly shaped grayish colored foci varying in size from that of a pinpoint to one millimeter in diameter. The mucosa of the left horn is more uniform in color except at its posterior end where the appearance is similar to that of the body. The color of mucosa is of a lighter gray color than is normally seen in a cow that has calved. The cotyledons vary in size from three to six millimeters and are of a grayish yellow color. Both oviducts are apparently normal. The left ovary is four and one-half centimeters in diameter and contains a cyst-like structure one and one-half centimeters in diameter. Left ovary is four centimeters in diameter. *B. coli communior* was obtained from exudate in uterine cavity. Cultures from the deeper layers were negative.

Histological examination: The epithelium of the cervical mucosa is not uniform in appearance. In places it is normal, in others the cells are swollen and many of them have lost their nuclei. Desquamation is observed in places. Many of the sub-epithelial capillaries are filled with blood and small sub-epithelial hemorrhages are seen in places. Local areas of edema are also observed. In places there are marked collections of cells under the epithelium. Here endothelial cells and lymphocytes predominate although there are a few polymorphonuclears and erythrocytes observed.

The mucosa of the uterine body varies from one to three millimeters in thickness and is covered by an epithelium sixteen to thirty microns in height. Numerous leucocytes are seen in the process of passing through the epithelium. In places the epithelial cells are clondy and the nuclei very faintly stained. The sub-epithelial cellular zone is not sharply differentiated but blends gradually with the deeper portion of the stroma. There is a marked leucocytic infiltration of the sub-epithelial zone. There are numerous collections of the leucocytes into groups explaining the appearance seen in the macroscopic examination. The interglandular tissue is thickened but partakes more of the nature of adult connective tissue. Only in places is there evidence of active proliferation. The glandular changes are marked. Many of the glands are apparently normal but many others show marked degenerative and disintegrative changes of the epithelium with round cell infiltration of the gland luminae.

Summary: Of the eleven cases presented here, all except numbers 996 and 17 were clinically sterile. Number 996 was slaughtered because of a peri-uterine abscess and number 17 was slaughtered because of aborting some seven weeks before. The anatomical alterations of the uterine mucosa vary in the different animals from slight fibrous thickening of the transverse cervical folds with no apparent alterations of the corporal and cornual mucosae (case number 18) to an atrophic endometritis (cases number 23 and 25). The lesions observed in varying degrees in the different cases are mucoid degeneration of the superficial epithelium, local and diffuse fibrosis of the uterine mucosae, leucocytic infiltration of the stroma and gland luminae and degeneration and disintegration of the glandular epithelium with diminution in the number of glands.

In the majority of cases the anatomical alterations are comparatively few and it is hardly conceivable that failure to breed was the result of loss of functional tissue of the uterine mucosae. Of course it is not known to what extent the uterine mucosa may be anatomically altered and yet remain functional but it may be logically assumed that considerable alterations are necessary to render the uterus permanently sterile. Surely some fibrosis of the mucosae with some loss of uterine glands should not render the uterus functionally inactive. This is not nature's way. Theoretically, before arriving at a conclusion (and conclusions cannot be drawn until more data are available) we must distinguish between the sequelae of an active condition and the effects of a condition still active. Judging from alterations of other functional organs considerable of the former are compatible with functional activity. This thought suggests two problems of research that are vital to the solution of the cause of sterility, viz: The alterations of the secretions and their effect on the male and female sexual cells, because of an active morbid condition of the uterine mucosae and second, the effects of such a condition on the cyclic functional activity of the ovary. The difficulty of obtaining suitable material for this kind of investigation is a great obstacle in the way of valuable research but the importance of this problem impels us to overcome this difficulty.

REPORT OF POULTRY SECTION.

Director R. S. Shaw,

Dear Sir:

1. Inheritance of higher fecundity.
 - (a) Can one isolate birds from a flock that will breed true to definite degrees of fecundity?
 - (b) Can one determine the definite degree of laying ability of fowls by outward examination of the fowl's body?
 - (c) Is higher fecundity secured through the sire's side or the dam's side?
2. Length of time necessary that a male be in the presence of females in order to secure fertile eggs.
 - (a) Does it vary with breeds of fowls?
 - (b) Does it vary with different months of the year?
 - (c) Does the age of a fowl make a difference in fertility of eggs?
3. To determine the anatomical factor in egg production. (Culling).
4. Does the pedigree of a fowl aid in the determination of high or low fecundity?
5. The value of a simple ration simply fed in order to secure heavy egg production.

The above problems have been considered during the past year. The section feels that it is coming closer to the point where poultry culture can be reduced to a more exact science. Facts and figures collected upon the above problems are on file in the office of the Poultry department.

Very truly,

C. H. BURGESS,

Poultry Husbandman.

East Lansing, Michigan, June 30, 1920.

REPORT OF THE UPPER PENINSULA EXPERIMENT STATION.

BY D. L. MCMILLAN, SUPERINTENDENT.

Director R. S. Shaw:

Dear Sir: The following is a report of the work done at the Upper Peninsula Experiment Station for the fiscal year ending June 30, 1920.

The crops experimental work has been in charge of Mr. G. W. Putnam, and the potato disease work in charge of Mr. J. E. Kofila. Their reports follow.

LAND CLEARING.

Plans were laid to clear 40 acres of land during the past year but labor conditions were such that it was impossible to get the work done without an excessive expenditure of money, consequently, but 20 acres were put under the plow and the other 20 but partially cleared.

Considerable work was done in other fields, leveling the land and removing stumps and rock. One and a half miles of fence were erected which has given us considerable more pasture land.

CROPS.

Our efforts are directed quite largely toward producing sufficient refuge to keep up a good herd of cattle and a flock of sheep. The greater part of the barley that was raised was distributed among the farmers of the Upper Peninsula at very reasonable rates for seeding purposes. Our intentions are to dispose of a large percentage of the Wolverine Oats and Oderbrucker Barley that is being raised this year, in the same way.

The sunflowers that were put in the silo last fall proved so satisfactory as dairy feed that a much larger acreage was put in this year.

LIVE STOCK.

The Station maintains a herd of high class Holsteins, a flock of sheep consisting of pure bred Rambouillets, Hampshires, Shropshires, and the different crosses of these. A small flock of Barred Rock chickens, a small herd of Duroc Jersey Hogs; also seven horses. It is the policy of this Station to sell all surplus stock that is suitable for breeding purposes at very reasonable prices to the farmers of the Upper Peninsula. During the year two cows, three heifers, four bulls have been sold.

All of the best ewe lambs were retained in the flock. The wethers, cull lambs and ewes were shipped to Chicago.

A Shropshire ram was purchased from Kniffen & Son, a Hampshire ram from Welch & Son, a Rambouillet ram, 10 Rambouillet ewes and 6 Shropshire ewes from the Michigan Agricultural College. Every ewe in the flock gave birth to one or more lambs and at the time the sheep went to the pasture there were 114% of lambs. Two horses were purchased in March from the Michigan Agricultural College.

BUILDINGS.

The new horse barn and the office building have been painted and an addition built on the west side of the sheep barn, 24x100 feet. This provides for the increase in the flock of sheep that is being maintained.

In April, 1920, the Stranberg farm consisting of 40 acres of land with the house and small barn located just west of the Station was purchased. This addition gives a house for our crops experimenter and a much needed increased acreage of land suitable for crops experimental work.

The reports of G. W. Putnam, Research Assistant in Farm Crops, and J. E. Kotila, Research Assistant in Plant Pathology, follow.

Mr. D. L. McMillan, Superintendent, U. P. Sub. Station.

I herewith report the experimental crop work at this station for the year ending July 1st, 1920.

In 1919 there were nineteen varieties of oats tested. These were harvested on August 10th. The three highest yielding varieties were Iowa 103, 60-day and Wis. Ped. No. 77. These oats were all of the 60-day sort. The exceptionally dry weather during June and July gave a season very favorable to the early oat. The Wolverine which is a medium early oat compared very favorably with the other varieties tested and gave the highest test weight per bushel of any. Wis. Ped. No. 14, a side oat selection from the Wisconsin Station gave the lowest yield per plot and also the lowest test weight per bushel.

There were ten varieties of spring wheat harvested on August 15th., all of which were of very poor quality due to the dry weather in July and also a severe epidemic of Black Stem rust (*puccinia graminis*). Of the ten varieties tested a strain of Marquis from the Ottawa, Canada, station gave the best returns. It, however, tested only 51 pounds per bushel. The lowest yielding variety was a hybrid sort obtained from the Wisconsin station. It tested 42 pounds per bushel.

Three varieties of barley were tested. Oderbrucker, Michigan 2-row and Michigan Black Barbless. The Michigan Black Barbless gave the highest yield per acre, however, the season was very unfavorable for barley. None of the barleys tested came up to the yield in an average year.

A cost account was kept of the production and harvesting of an acre of rutabagas. With the labor situation of 1919, the figures given would not apply to an average season. The total cost of production per acre was \$38.10 and the cost of harvesting and storing \$34.50 making a total of \$72.60 with a yield of 20 tons per acre, making a cost of \$3.68 per ton.

One acre of sunflowers were grown for silage material. A yield of approximately 20 tons was obtained.

Two acres were devoted to experimental potatoes, Mr. J. W. Weston and Mr. J. E. Kotila cooperating on this work. The following cultural plots were harvested, not working before plants were up vs. working every five days before plants were up, shallow to deep cultivation, vs. deep to shallow, flat culture, vs. hill culture. Variety testing was confined to five varieties, Green Mountains, Idaho Rurals, Rurals, Russet Burbank and Early Ohios. Acid phosphate was applied at the rate of 500 pounds and 250 pounds per acre, vs. no application. Plots were treated for scab and black scurf control with Mercuric chloride and for-

malin, vs. no treatment. Green sprouted, vs. unsprouted seed was tried on two different dates of planting. In addition to this work 250 tubers were planted as tuber units representing six varieties, the intention being to make selections of these units to establish certified seed of the varieties important to the Upper Peninsula.

The following experimental plots have been planted in 1920 to form the basis of this year's work. The same varieties of oats tested in 1919 are again in the test in addition. Five new varieties obtained from Upper Peninsula farms are included also a rate of seeding test of from two to five bushels per acre:

The Marquis Spring Wheat seems to be the variety best suited to the area so the general testing of varieties has been discontinued and only new promising sorts will be tried in comparison with the Marquis as a standard. Eight different dates of seeding were tried for Marquis Spring Wheat ranging one week apart from April 20th to June 7th.

Fourteen different dates of planting winter wheat is being tried ranging from August 13th to October 24th, the object being to determine what effect date of seeding has on winter killing.

The barley test of 1919 is being repeated for 1920. In addition a rate of seeding test is planted ranging from one and one-half to three and one-half bushels per acre.

Seven varieties of field peas are being tested for yield of forage and threshed peas. Also a rate of seeding test to determine the best rate to seed for forage and threshed grain ranging from two to four bushels per acre.

Work with sunflowers was confined to time of planting, distance apart of spacing rows and rate of seeding for best silage production.

Ten different kinds of annual forage crops are being tested as to their suitability for annual hay in the Upper Peninsula.

The potato work of 1919 is being continued for 1920 with elaboration on the tuber unit work; the desire being to isolate superior strains free from certain classes of potato diseases. Mr. Weston and Mr. Kotila continue to cooperate.

In addition to the station work, cooperative tests are being conducted in the various counties of the Upper Peninsula with oats, barley and alfalfa; also quite extensive work in cooperation with Professor J. A. Jeffery on muck soil in the Seney swamp area.

Yours very truly,

G. W. PUTNAM,

Research Assistant in Farm Crops.

POTATO DISEASE INVESTIGATIONS.

As a result of the demands of the Upper Peninsula farmers, the investigation of potato diseases was commenced in 1919 at the Upper Peninsula Experiment Station, under the supervision of Dr. G. H. Coons, Plant Pathologist of the Michigan Agricultural Experiment Station at East Lansing.

The work during the 1919 season consisted of seed treatment experiments for the control of seed-borne diseases such as Scab and Black Scurf (*Rhizoctonia*) and experiments on the Blackleg, Mosaic, Leaf Roll

and Streak diseases of the potato. Experiments were also conducted to determine whether the Leaf Hopper, *Empoasca mali*, was responsible for the burning of the tips and margins of the leaves commonly known as "tipburn." As Blackleg during seasons favorable to the disease results in losses of from 10 to 75%, the major part of the time was spent investigating this disease. Hill selections were also made during the growing season to determine whether Mosaic, Leaf Roll and Streak diseases are disseminated from diseased to neighboring hills, the tubers from these selections being saved for 1920 planting.

The work during the 1920 season has been a continuation of the work started in 1919 and in addition has been supplemented by life history studies of the Potato Leaf Hopper, *Empoasca mali*, and spraying experiments with Bordeaux mixture for its prevention. Experiments were also conducted to determine whether potato diseases are disseminated by potato plant lice and leaf hoppers.

The field work has been supplemented by work in the laboratory on isolation and study of the causal organisms of the various potato diseases, approximately one-half of the investigator's time being devoted to field work and one-half to laboratory researches.

J. E. KOTILA,
Research Assistant in Plant Pathology.



BULLETINS

OF THE

Agricultural College Experiment Station

ISSUED DURING THE

YEAR ENDING JUNE 30, 1920.

COMMERCIAL FEEDING STUFFS.

ANDREW J. PATTEN, C. F. BARNUM, E. F. BERGER, A. L. LEWIS,
AND M. L. GRETTEMBERGER.

The present feeding stuffs law (Act 91, P. A. 1917) became operative April 1, 1918. As the full text of the act was printed in Bulletin No. 279 only the main provisions will be discussed. Copies of the law will be furnished upon request.

Label. Every lot or parcel of "commercial feeding stuffs" shall bear on the bags or tags attached thereto a statement certifying, 1st, the net weight of the contents of the package, lot, or parcel; 2nd, the name, brand or trademark; 3rd, the name and principal address of the manufacturer or person responsible for placing the commodity on the market; 4th, the minimum percentage of crude protein, the minimum percentage of crude fat and the maximum percentage of crude fibre; 5th, the specific name of each ingredient used in its manufacture.

Registration. All "commercial feeding stuffs" within the meaning of the act must be registered annually, on or before January 1st or before the feed is placed on sale and the license fee is \$20.00 per brand.

Samples not required. The forwarding of samples at the time of applying for license is not necessary except when requested by the administrative officer.

Registration may be refused or cancelled. The administrative officer may refuse to license a brand if the name appears to be deceptive or misleading. He also has power to cancel a license if it appears, at any time, that any of the provisions of the law have been violated.

Materials exempt from license fee. Unmixed whole seeds and grains; unmixed meals made directly from the entire grains of corn, wheat, rye, barley, oats, buckwheat, flaxseed, kafir and milo; corn and oats feed made by grading together the pure grains of corn and oats; wheat rye and buckwheat brans or middlings when unmixed with other materials; whole hays, straws, ensilage and corn stover when unmixed with other materials and all materials containing 60 per-cent or more of water.

The definitions adopted by the Association of Feed control Officials will be considered official in Michigan, and it is expected that the manufacturers will adhere to them as closely as possible.

RULES.

The following rules were passed by the State Board of Agriculture at a meeting held March 20, 1918, in East Lansing, Michigan:

RULE No. 1. "*Wheat Bran* with Screenings not exceeding Mill Run" is interpreted as meaning bran to which has been added, by a separate process, the whole or a part of the screenings separated from the particular lot of wheat producing the bran. The Screenings may or may not be reduced.

RULE No. 2. "*Wheat Middlings* with Screenings not exceeding Mill Run" is interpreted as meaning middlings to which have been added, by a separate process, the whole or a part of the screenings separated from the particular lot of wheat producing the middlings. The screenings may or may not be reduced.

RULE No. 3. "*Wheat Bran* and *Wheat Middlings* when labelled as containing "Screenings not exceeding Mill Run" are considered to be "Commercial Feeding Stuffs" within the meaning of the law and subject to license. This rule shall take effect April 1st, 1918.

RULE No. 4. "*Statement of Guaranteed Analysis*. Section 2 of the Feeding Stuffs law is interpreted to mean that only the minimum guarantees for Protein and Fat and the maximum guarantee for Crude Fiber may be stated on the labels. The sliding guarantee is prohibited. This rule shall take effect April 1st, 1918."

THE FOLLOWING ADDITIONAL RULES WERE PASSED BY THE STATE BOARD OF AGRICULTURE ON MAY 21ST, 1919.

RULE No. 5. *Inert Materials*. It is permissible to use grit, oyster shells, charcoal, and similar materials in compounding poultry feeds, providing, that not more than five (5) per cent of such inert material is used. The words "grit," "charcoal," etc., must constitute a part of the brand name of all feeds containing these ingredients and must be printed in the same size and face of type as the balance of the name, as PRIME POULTRY FEED WITH GRIT AND CHARCOAL.

RULE No. 6. *Seeds, Field Seeds, Miscellaneous Seeds*. These terms will not be accepted in the list of ingredients to cover a mixture of weed seeds. When such seeds are used in excess of five (5) per cent, the common name of each variety of seed must be given on the registration form and also on the tag or label. When used in amount less than five (5) per cent they may be registered as screenings providing the source of the screenings is given, as "clover screenings," "wheat screenings," etc.

RULE No. 7. *Screenings*. Screenings if sold as such without grinding, need not be licensed. If ground, they become a mixed meal and must be registered and labeled.

RULE No 8. *Oat Feed*. This term will not be accepted when used to indicate any material other than whole or ground oats. Mixtures of

oat shorts, oat middlings and oat hulls will not be accepted under the term and the name of each separate ingredient will be required.

RULE No. 9. *Changing Guarantees.* Guarantees either as regards composition nor ingredients will be changed only upon application by the manufacturer accompanied with a statement of the reasons for making such change. The old license certificate must be surrendered before a new one will be issued.

RULE No. 10. *Unlicensed Feed.* When any unlicensed "commercial feeding stuffs" as defined in section 1 of the law is found being offered for sale, the agent or dealer offering the feed for sale is notified and advised to remove it from sale. Those failing to accept the advice and heed the notice will be reported for violation of the law.

RULE No. 11. *Samples not meeting Guarantee.* In the case of appreciably deficient or of adulterated samples the manufacturer is given ten days' advance notice in which to file objections. A portion of the official sample is furnished if requested. As soon as the deficiency or adulteration is detected, the agent or person offering the feed for sale is notified and advised to remove it from sale. Those failing to accept this advice will be reported for violation of the law.

RULE No. 12. *Discarding or Substituting Samples.* All requests for discarding or substituting samples will be refused unless an error on the part of an agent of the State Board of Agriculture can be shown.

RULE No 13. *Prosecutions.* Original shippers of unlicensed, adulterated or misbranded feeds will be prosecuted in all cases where it is possible to do so either under the State law or through co-operation with the United States Department of Agriculture under the Federal Food and Drugs Act. *Local dealers*, however, are directly responsible under the law for the feed they offer for sale and will be held accountable for failure of such feed to meet the requirements of the law, especially for selling a feed when notified to withdraw it from sale.

RULE No. 14. *Statement of Ingredients.* The attention of those desiring to register feeds for sale in this State is especially directed to the requirement of the law regarding the declaration of ingredients. Each and every substance used in compounding feed must be given in the list of ingredients without regard to the purpose for which it may be used.

RULE No. 15. *Net Weight.* The law requires that the "net weight of the package lot or parcel" be stated on the label. A statement of the gross weight only, will be considered to be a case of misbranding and dealt with accordingly.

RULE No. 16. *Fees.* The license fee, required by law, is twenty dollars (\$20.00) per brand. This should be paid on or before January 1st of each year or before the feed is placed on sale. All requests for a reduction of the license fee when the registration is made after the first of the year will be refused.

RULE No. 17. *Rebates.* The Michigan feed law makes no provision for the payment of rebates to cover deficiencies and although this practice often shows the good intention of the manufacturer, the payment of such rebates will have no bearing on any subsequent action which may

be taken in cases of violation of the law. When rebates are paid, dealers will be expected to prorate them to the purchasers so that the consumers may receive their benefit.

POINTS OF INTEREST TO DEALERS.

Represent only Reliable Firms and before purchasing feed for resale in Michigan, find out if the particular feed has been properly licensed by the manufacturer, broker, or party responsible for its shipment into the State. The State law has no jurisdiction over parties residing outside of the State and the only way they can be reached is through the U. S. Department of Agriculture for a violation of the Federal Food and Drugs Act. Failure to license a feed in Michigan would not be a violation of the Federal law and if properly tagged, shipment into the State cannot be prevented. The Michigan law becomes operative only when such feed is offered for sale within the State. Ignorance of the provisions of the law is not sufficient grounds for defense. When the inspectors find an unlicensed feed being offered for sale the dealer is given written notice and requested to discontinue the sale until the person or concern responsible for shipping the product into the State has complied with the requirements of the law. *Dealers who continue to sell unlicensed feeds after due notice has been given will be held responsible and evidence of the violation of the feeding stuffs law will be submitted to the Prosecuting Attorney in the county wherein the violation occurs.*

The feeding stuffs law requires that when feed is offered for sale in bulk the dealer shall keep on hand cards upon which shall be printed the information indicated under paragraph two, page three, and upon request the purchaser shall be furnished with such a card. This requirement applies to all sales no matter how small and must be fulfilled by dealers and grocers who make a practice of selling feeds from open barrels or tubs. That no hardship may be worked on those handling but small quantities of feed, the administrative officer holds that the law is complied with if the dealer attaches to the container from which the feed is sold a placard giving the information above specified.

Frequently it occurs that carload shipments reach their destination untagged. In such cases the dealer should telephone or telegraph the manufacturer or jobber immediately for proper tags and insist upon getting them at once as the sale of untagged feeds is not permissible under any circumstances. Tags sent forward by mail or placed in a carload of feed but not attached to the bags should be put on as the car is unloaded. Some responsible person should give the matter of proper tagging careful attention rather than trust it to some irresponsible laborer.

Retain Freight Bills. The State inspectors of feeding stuffs are also federal inspectors and authorized to take samples of shipments made in violation of the Federal Food and Drugs Act. In order to establish evidence of interstate shipment it is necessary to secure copies of the freight bill, bill of lading and bill of sale covering a shipment. Dealers should, therefore, keep on file all the documents and papers relating in any way to all interstate shipments of feed stuffs.

POINTS OF INTEREST TO PURCHASERS.

Consult the annual bulletin and find out what companies are most consistently meeting their guarantees.

Do not buy a feed simply because it is cheap without comparing the guaranteed analysis with that of other feeds that may be available and also examine it carefully to determine, if possible, the ingredients of which it is composed. In these times of high prices, one should consider these points carefully.

Do not send samples for analysis without first writing for instructions on how to secure a representative sample. A sample from one bag or a small handful taken from the top of several bags is not representative and an analysis of such a sample would be of no value. The cost of making an analysis is considerable and we cannot take the time to analyze samples that are not representative of the lot from which they were taken. Our inspectors are continually collecting samples of feeding stuffs and in many cases we can furnish information concerning a particular brand of feed without making another analysis.

When purchasing feed in ear lots, an inspector will be sent to draw samples if the office of the chemist in charge is notified upon arrival of the car.

Do not accept feed in untagged or unlabeled bags except such feeds as are exempt from license as heretofore mentioned. An untagged package gives the purchaser no guarantee as to analysis or ingredients and furthermore the product is sold in violation of the feeding stuffs law. Such cases should be brought to the attention of the office of the chemist.

When buying bulk feeds that are subject to license, demand of the seller a printed guarantee giving the chemical analysis and ingredients—the law provides that the purchaser may have this information.

CO-OPERATION WITH U. S. DEPARTMENT OF AGRICULTURE.

Through a plan of cooperation devised by the U. S. Department of Agriculture the State inspectors are empowered to collect samples from interstate shipment of feed stuffs found in Michigan under the Food & Drugs Act. In this cooperative work fifteen cases were referred to the laboratory of the central inspection district in Chicago; eleven of the samples were collected on account of deficiencies in protein, and four were taken at the suggestion of the Chief Inspector of the central inspection district.

DEFINITIONS.

The following definitions of Feeding Stuffs and by-products used for feeding purposes have been adopted by the Association of Feed Control Officials of the United States at their several meetings, and, in the interests of uniformity, it is urged that all manufacturers and millers adhere to them as closely as possible in labeling the feeds intended for sale in Michigan.

Meal is the clean, sound, ground product of the entire grain cereal or seed which it purports to represent.

Chop is a ground or chopped feed composed of one or more different cereals or by-products thereof. If it bears a name descriptive of the kind

of cereals, it must be made exclusively of the entire grains of those cereals.

Screenings are the smaller imperfect grains, weed seeds and other foreign material having feeding value, separated in cleaning the grain.

Alfalfa Meal is the entire alfalfa hay ground, and does not contain an admixture of ground alfalfa straw or other foreign materials.

ANIMAL PRODUCTS.

Blood Meal is ground dried blood.

Cracklings are the residue after partially extracting the fats and oils from the animal tissue. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

Digester Tankage is the residue from animal tissue exclusive of hoof and horn, specially prepared for feeding purposes by tanking under live steam, drying under high heat, and suitable grinding. If it contains more than 10 per cent of phosphoric acid (P_2O_5), it must be designated Digester Meat and Bone Tankage.

Meat Scrap and Meat Meal are the ground residues from animal tissue exclusive of hoof and horn. If they contain more than 10 per cent of phosphoric acid (P_2O_5), they must be designated Meat and Bone Scrap, and Meat and Bone Meal. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

BREWERS' AND DISTILLERS' PRODUCTS.

Brewers' Dried Grains are the properly dried residue from cereals obtained in the manufacture of beer.

Distillers' Dried Grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereal predominating.

Malt Sprouts are the sprouts of the barley grain. If the sprouts are derived from any other malted cereal, the source must be designated.

BUCKWHEAT PRODUCTS.

Buckwheat Shorts or Buckwheat Middlings are that portion of the buckwheat grain immediately inside of the hull after separation from the flour.

CORN PRODUCTS.

Corn Bran is the outer coating of the corn kernel.

Corn Feed Meal is the by-product obtained in the manufacture of cracked corn, with or without aspiration products added to the siftings, and is also the by-product obtained in the manufacture of table meal from the whole grain by the non-degerminating process.

Corn Germ Meal is a product in the manufacture of starch, glucose and other corn products, and is the germ layer from which a part of the corn oil has been extracted.

Grits are the hard, flinty portions of Indian corn, without hulls and germ.

Corn Gluten Meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the

bran, by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

Corn Gluten Feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germ by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

Hominy Feed, Hominy Meal or Hominy Chop is a kiln-dried mixture of the mill run bran coating, the mill run germ, with or without a partial extraction of the oil and a part of the starchy portion of the white corn kernel obtained in the manufacture of hominy, hominy grits and corn meal by the degerminating process.

Yellow Hominy Feed, Yellow Hominy Meal or Yellow Hominy Chop is a kiln-dried mixture of the mill run bran coating, the mill run germ, with or without a partial extraction of the oil and a part of the starchy portion of the yellow corn kernel obtained in the manufacture of yellow hominy grits and yellow corn meal by the degermination process.

OIL CAKE.

Oil Cake is the residue cake obtained after extraction of part of the oil by crushing, cooking and hydraulic pressure from seeds screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "oil cake" shall be understood to designate the product obtained from partially extracted, screened and cleaned flaxseed. When used to cover any other product, the name of the seed from which it is obtained shall be prefixed to "oil cake."

Ground Oil Cake is the product obtained by grinding oil cake. When used alone, the term "ground oil cake" shall be understood to designate the product obtained from partially extracted, screened and cleaned flaxseed. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "ground oil cake."

COTTONSEED PRODUCTS.

Cottonseed Meal is a product of the cottonseed only, composed principally of the kernal with such portion of the hull as is necessary in the manufacture of oil; provided that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent of protein.

Choice Cottonseed Meal must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint and must contain at least 41 per cent of protein.

Prime Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.6 per cent of protein.

Good Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and must contain at least 36 per cent of protein.

Cottonseed Feed is a mixture of cottonseed meal and cottonseed hulls containing less than 36 per cent of protein.

Cold Pressed Cottonseed is the product resulting from subjecting the

whole undecorticated cottonseed to the cold pressure process for the extraction of oil, and includes the entire cottonseed less the oil extracted.

Ground Cold Pressed Cottonseed is the ground product resulting from subjecting the whole undecorticated cottonseed to the cold pressure process for the extraction of oil, and includes the entire ground cottonseed less the oil extracted.

LINSEED AND FLAX PRODUCTS.

Linseed Meal is the ground product obtained after extraction of part of the oil from ground flaxseed screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes, provided that the final product shall not contain over 6 per cent of weed seed and other foreign materials and provided further that no portion of the stated 6 per cent of weed seeds and other foreign materials shall be deliberately added.

Oil Meal is the ground product obtained after the extraction of part of the oil by crushing, cooking and hydraulic pressure, or by crushing, heating and the use of solvents from seeds which have been screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "Oil Meal" shall be understood to designate linseed meal as defined. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to the words "oil meal."

Old Process Oil Meal is the ground product obtained after extraction of part of the oil by crushing, cooking and hydraulic pressure from seeds screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "Old Process Oil Meal" shall be understood to designate linseed meal as defined, made by the old process. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "old process oil meal."

New Process Oil Meal is the ground product obtained after extraction of part of the oil by crushing, heating and the use of solvents from seeds screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone "New Process Oil Meal" shall be understood to designate linseed meal as defined, made by the new process. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "new process oil meal."

Flax Plant By-Product is that portion of the flax plant remaining after the separation of the seed, the bast fibre and a portion of the shives, and consists of flax shives, flax pods, broken and immature flax seeds and the cortical tissue of the stem.

Ground Flaxseed of Flaxseed Meal is the product obtained by grinding flaxseed which has been screened and cleaned of weed seeds and other foreign material by the most improved commercial processes, provided that the final product shall not contain over 4 per cent of weed seeds and other foreign materials, and provided further that no portion of the stated 4 per cent of weed seeds and other foreign materials shall be deliberately added.

Unscreened Flaxseed Oil Feed is the ground product obtained after ex-

traction of part of the oil from unscreened flaxseed by crushing, cooking and hydraulic pressure, or by crushing, heating and the use of solvents. When sold without grinding the unground product shall be designated as "unscreened flaxseed oil feed cake."

Ingredients of Unscreened Flaxseed Oil Feed—Ground cake from partially extracted flaxseed and foreign seeds (wheat, wild buckwheat pigeon grass, wild mustard, etc)

Screenings Oil Feed is the ground product obtained after extraction of part of the oil by crushing, cooking and hydraulic pressure, or by crushing, heating and the use of solvents from the smaller imperfect grains, weed seeds and other foreign materials having feeding value separated in cleaning the grain. The name of the grain from which the screenings are separated shall be prefixed to "screenings oil feed."

OAT PRODUCTS.

Oat Groats are the kernals of the oat berry.

Oat Hulls are the outer chaffy coverings of the oat grain.

Oat Middlings are the floury portion of the oat groat obtained in the milling the rolled oats.

Oat Shorts are the covering of the oat grain lying immediately inside the hull, being a fuzzy material carrying with it considerable portions of the fine floury part of the groat obtained in the milling of rolled oats.

Clipped Oat By-Product is the resultant by-product obtained in the manufacture of clipped oats. It may contain light, chaffy material broken from the ends of the hulls, empty hulls, light, immature oats and dust. It must not contain an excessive amount of oat hulls.

PEANUT PRODUCTS.

Peanut Oil Cake is the residue after the extraction of part of the oil by pressure or solvents from peanut kernels.

Peanut Oil Meal is the ground residue after the extraction of part of the oil from peanut kernels.

Unhulled Peanut Oil Feed is the ground residue obtained after extraction of part of the oil from whole peanuts, and the ingredients shall be designated as "peanut meal and hulls."

RICE PRODUCTS.

Rice Bran is the cuticle beneath the hull.

Rice Hulls are the outer chaffy coverings of the rice grain.

Rice Polish is the finely powdered materials obtained in polishing the kernel.

WHEAT PRODUCTS.

Wheat Bran is the course outer coatings of the wheat berry obtained in the usual commercial milling process from wheat that has been cleaned and scoured.

Shorts or Standard Middlings are the fine particles of the outer and inner bran separated from bran and white middlings.

Wheat White Middlings or White Middlings are that part of the offal of wheat intermediate between shorts or standard middlings and red dog.

Shipstuff or Wheat Mixed Feed is a mixture of the products other than the flour obtained from the milling of the wheat berry.

Red Dog is a low grade wheat flour containing the finer particles of bran.

Wheat Bran with Mill Run Screenings is pure wheat bran plus the screenings which were separated from the wheat used in preparing said bran.

Wheat Bran with Screenings not Exceeding Mill Run is either wheat bran with the whole mill run of screenings or wheat bran with a portion of the mill run of screenings, provided that such portion is not an inferior portion thereof.

MISCELLANEOUS PRODUCTS.

Palm Kernel Oil Meal is the ground residue from the extraction of part mixture of cereals, malt and malt sprouts (sometimes cottonseed meal) obtained in the manufacture of yeast or vinegar and consists of corn or corn and rye from which of most the starch has been extracted, together with malt added during the manufacturing process to change the starch to sugars, and malt sprouts (sometimes cotton seed meal) added during the manufacturing process to aid in filtering the residue from the wort and serve as a source of food supply for the yeast.

Palm Kernel Oil Meal is the ground residue from the extraction of part of the oil by pressure or solvents from the kernel of the fruit of the *Elaeis guineensis* or *Elaeis maniococca*.

Ivory Nut Meal is ground ivory nuts.

TENTATIVE DEFINITIONS.

Barley Feed is the entire by-product resulting from the manufacture of pearl barley made from clean barley.

Barley Mixed Feed is the entire offal from the milling of barley flour from clean barley and is composed of barley hulls and barley middlings.

Dried Beet Pulp is a material obtained by drying the residue from sugar beets which have been extracted in the process of manufacturing sugar and shall not contain excessive amounts of crowns, tails or sand.

Cocoanut Oil Meal is the ground residue from the extraction of part of the oil from the meat of the cocoanut.

Wheat Bran consists of the coarse outer coatings of the kernel obtained in the usual commercial process of milling from wheat that has been cleaned and scoured.

Shorts or Standard Middlings consists mostly of the fine particles of bran and germ and contains very little of fibrous offal obtained from the "tail of the mill."

Gray (or total) *Shorts* consists of the fine particles of the outer bran, the inner of "Bee-wing" bran, the germ and the offal or fibrous material, obtained in the last reductions in milling.

White Shorts or White Middlings consists of a smaller portion of the fine bran particles and the germ and a much greater portion of the fibrous offal from the "tail of the mill."

Red Dog consists of a mixture of low-grade flour, fine particles of bran and the fibrous offal from the "tail of the mill."

Wheat Mixed Feed consists of pure wheat bran and the gray or total

shorts or middlings combined in the proportions obtained in the usual process of commercial milling.

Wheat Bran and Standard Middlings consists of the two commodities as defined above mixed in the proportions obtained in the usual process of commercial milling.

(NOTE—If to any of the foregoing brands of feed there should be added screenings, or scourings as hereinafter defined, either ground or unground, bolted or unbolted, such brand shall be so registered, labeled and sold as clearly to indicate this fact. The word "Screenings" or "Scourings," as the case may be, shall appear as a part of the name or brand and shall be printed in the same size and face of type as the remainder of the brand name.)

Screenings consists of the smaller imperfect grains, weed seeds and other foreign materials having feeding value separated in cleaning the grain.

Scourings consists of such portions of the cuticle, brush, white caps, dust smut, and other materials as are separated from the grain in the usual commercial process of scouring.

COURT CASES.

Two cases of violation of the law were prosecuted during the year.

The first instance was against the Watson-Higgins Milling Co., Grand Rapids, Michigan, for shipping unlicensed and untagged hog feed. The shipment in question was made to the Whalen Grain & Produce Co., Sparta, Michigan, and was invoiced as "Corn feed meal." A corrected invoice sent later listed the shipment as "Hog meal." Examination of the sample showed it to be composed of corn feed meal, wheat, oats, buckwheat and screenings. Notice of the violation was sent to Watson-Higgins Milling Co. They failed to make any explanation of the violation and the evidence was accordingly presented to the prosecuting attorney of Kent County. The case was tried before Justice Beebe at Sparta who rendered a decision for the people and imposed a fine of \$25.

An appeal was made to the Circuit Court but the Judge ruled the case out on technical grounds.

The second case was against the Wm. A. Coombs Milling Co., Coldwater, Michigan. This company persisted in shipping "Wheat bran with screenings not exceeding mill run" without complying with the law. One shipment was found being offered for sale by the Bronson Milling Co., Bronson, Michigan in which the screenings were present in large quantities. Complaint was accordingly made and before the case came to trial an officer of the company appeared before the Justice, plead guilty and paid the fine of \$25.00 that was imposed. They also complied with the law and took out a license, thus permitting the sale of the bran and screenings.

DISCUSSIONS OF RESULTS.

In the following tables are given the results of analyses of 1530 feeds, twenty-two of which are not subject to license. Of the 1508 licensed feeds 97 (6.4%) were below guarantee in protein; seventy-two (4.8%) were deficient in crude fat and one hundred twenty-six or 8.4% contained an excess of crude fiber. These figures show a very satisfactory reduction in the number of violations of the feeding stuffs law. There has been a steady decrease each year in the number of feeds that have failed to conform to guarantee as is shown by the following table:

Year ending July 1,	1916	1917	1918	1919
Deficient in protein.....	15%	11%	8.3%	6.4%
Deficient in crude fat.....	11.5	8	7.5	4.8
Excess of fiber.....	9.9	15.1	12.5	8.4

In making these computations the following allowances for variations from guarantee were made, protein 1.0 per cent, fat 0.5 per cent and fiber 1.0 per cent.

All samples of mixed feeds were examined microscopically to determine the ingredients and those identified are given in the table of analyses. It is not claimed that *every* ingredient in each feed was identified as a material could be present in so small a quantity as to make its identification almost if not quite impossible.

The term "Oat meal mill by-products" will frequently appear in the list of ingredients. In all cases this refers to oat hulls, oat shorts and oat middlings in the proportion, presumably, in which they occur as by-products in the manufacture of oat meal, which is approximately as follows: oat hulls 90 per cent, oat shorts 8 per cent, oat middlings 2 per cent. This product is essentially oat hulls and the analysis shows it to possess only a very slightly higher feeding value than the clear hulls.

Concerning samples No. B 4448 Ryde's Milk Mash and No. B 4853 Ryde's Cream Calf Meal, Ryde & Co., in explanation for the high crude fiber results, state that they received a poor grade of alfalfa meal, some of which was used before the poor quality was detected and further that in moving the new plant some difficulties were experienced with labor and machinery.

A discussion of the results for each class of feeding stuffs follows:

COTTONSEED MEAL.

One hundred forty-three samples of cottonseed meal, 37 more than last year, were analyzed. A great majority of these were the "good" grade, guaranteed to contain 36 per cent protein. This is the lowest grade of meal recognized and is made by adulterating the higher grade

meals with hulls by adding hulls to the kernals before pressing out the oil.

During the first year of feed inspection, by this office, practically all of the cottonseed shipped into the State was tagged as 41 per cent meal but the actual quality was no better than that shipped during the past year tagged as 36 per cent meal, and 51 per cent of all shipments were below guarantee in protein while during the past year only 14.7 per cent of the inspected shipments were below guarantee in protein.

While one result of the feed inspection has been to bring about a more truthful labelling of the meal it is to be regretted that it has not, at the same time, resulted in raising the standard of quality. This however, can only be brought about by the consumers demanding the higher grade meals. Only three shipments of "Choice" meal (41% protein) were found in the State during the past year and two of these were found to be below guarantee in protein and above in crude fiber.

Retail prices obtained by the inspectors for the 36 per cent meal ranged from \$50.00 per ton to \$4.00 per cwt., the average being \$65.40. The average percentages for protein and fat were 36.7 and 6.7 respectively.

Six samples of "Prime" cottonseed meal (38.6% protein) were drawn, one of which was below guarantee in protein and three contained an excess of fiber. The average retail price was \$66.70 and the average percentages for protein and fat were 38.6 and 6.7 respectively.

COTTONSEED FEED.

Of eleven samples of cottonseed feed drawn all were found to be equal to or above the guaranteed analysis. This feed is not popular with Michigan feeders and as a rule the difference in price between cottonseed feed and cottonseed meal is not commensurate with the difference in feeding value as the following table will show:

	Average protein %	Average fat %	Average retail price.	Pounds for one dollar.	
				Protein.	Fat.
Cottonseed meal—					
36% grade.....	36.7	6.7	\$65.40	11.2	2.0
38.6%.....	38.6	6.7	66.70	11.6	2.0
Cottonseed feed.....	20.2	3.7	53.18	7.6	1.4

LINSEED MEAL.

Sixty-nine samples of this feed were collected and analyzed. All were fully equal to the guarantees in every respect. Retail prices were found to range from \$60 per ton to \$4.75 per cwt.

DISTILLERS' GRAINS.

This class of feed is fast disappearing from the market and during the past year only one sample was found. This was found to be deficient in fat.

YEAST AND VINEGAR GRAINS.

Only two samples of this class of feed were taken both of which were equal to guarantee. This feed is sometimes confused with brewers' grains and by some feed manufacturers is used in place of brewers' grains when the latter is declared. In mixed feeds containing a number of ingredients it is very difficult to distinguish between yeast or vinegar grains and brewers' grains. The yeast and vinegar grains are inferior to brewers' grains as they have less protein and considerably more fiber.

MALT GRAINS.

This feed is quite similar to brewers' grains and can well be substituted for them in mixed rations. It was offered for sale at an average price of \$53.75 per ton. The five samples taken were in no way deficient.

GLUTEN FEED.

Samples were drawn from eighteen lots of gluten feed ranging in price from \$56 to \$70. Five samples were below guarantee in protein. None were deficient in fat or contained an excess of crude fiber.

HOMINY FEED.

Eleven samples of hominy feed were taken representing the product of six manufacturers. All samples conformed closely to guarantee except one which was low in protein. This feed retailed at prices between \$53.50 and \$60.00 per ton.

CORN GERM MEAL.

But six lots of corn germ meal were sampled, all the product of one concern. With the exception of one sample which was deficient in protein, all were well above the guarantees for protein and fat. Corn germ meal is the residue from corn germs after the corn oil has been extracted. It has a feeding value about equal to wheat middlings. The average price of the shipments sampled was \$62 per ton.

CORN FEED MEAL.

The analyses of 13 samples of corn feed meal are shown in the tables. Of this number three were below guarantee in both protein and fat and one in fat only. The average percentage of fat found in these four samples was 3.5 while the average guarantee was 7.8 per cent. Such a variation between the guaranteed and found results indicates gross carelessness on the part of the manufacturers. The retail price varied from \$2.30 per cwt. for a lot sampled late in the fall of 1918 to \$72.00 per ton for a shipment found in June, 1919.

ANIMAL BY-PRODUCT.

In this classification are included digester tankage of all grades, meat scraps and meal and poultry bone. Four of the 27 samples collected were below guarantee in protein; practically all were above the guarantee for fat and but one contained an excess of crude fiber.

DRIED BEET PULP.

Seven samples of this product were analyzed and all were found to conform closely to the guaranteed analysis. Prices on this feed varied from \$46 to \$55 per ton.

ALFALFA MEAL.

No deficiencies are found in the results of analysis of seven samples of alfalfa meal. The highest priced lot was offered for sale at \$56.10 per ton and the lowest price, \$40, was found in a town less than ten miles distant from the former. An explanation for a difference of \$16.10 per ton on two lots of the same sort of feed, sold under practically the same guarantee, is difficult to find.

CALF MEALS.

The average analysis of 40 samples of calf meal collected during the past year is as follows: protein 23.7%, fat 5.2%, crude fiber 5.6%. The average price was \$6.43 per cwt., but instances were found where the price was \$15 and even \$20 for meals having no unusual composition. Nine of the samples (22.5%) were deficient in protein; 10 or 25% were deficient in fat; and six (15%) contained an excess of fiber. There can be no legitimate excuse for so many failures to comply with guaranteed analysis in one class of feeds. Manufacturers should reduce their guarantees to conform with the analysis of their particular feeds or better the quality of the feeds to meet the guarantees. Purchasers should remember, that according to the results obtained last year, in buying calf meal they stand approximately one chance in four of getting an article that is below guarantee and that at a high price.

HOG FEEDS.

Results on 58 samples of hog feeds are reported this year; of this number 8.6% were below guarantee in protein; 5.2% were below in fat; and 12.1% contained an excess of fiber over the guarantee. The average analysis was protein 15.9%, fat 4.3% and fiber 7.9%. The lowest price was \$42 per ton and the highest \$5.00 per cwt., the latter being for a feed similar to calf meal and intended for weanling pigs.

DAIRY AND STOCK FEEDS.

Two hundred and seventy-three samples were collected and analyzed. Eighteen of 6.6% and 19 or 7% were below guarantee in protein and fat respectively and 27 or 9.9% contained an excess of fiber. This is a marked improvement over last year when the corresponding figures were 7.1%, 20.3% and 15.9%. While the price of this class of feed has increased tremendously during the past three years the rate of increase has not been out of proportion to the increases noted for the other classes of feed.

In examining the lists of ingredients used in compounding the various dairy feeds it will be observed that a large number of materials are used in which a wide range in digestibility occurs. In purchasing dairy feeds on the present market one should carefully study the composition and avoid those that contain large amounts of low grade feed.

In order to better show the average percentage composition, the dairy and stock feeds are given under separate headings in the table of summaries while in the table giving the detail of inspection the two classes are combined. This is true of these feeds both with and without molasses.

MOLASSES DAIRY AND STOCK FEEDS.

Of this class of feeding stuffs, 80 in number, 10% were deficient in protein; six or 7.5% were deficient in fat, and 13 (16.3%) contained an excess of fiber. The corresponding percentages reported last year were 19.5, 13.0 and 35.1. This shows a commendable decrease in the number of deficiencies.

HORSE FEEDS.

Samples of 18 horse feeds containing no molasses were analyzed and all conformed to guarantee except one which was high in fiber content. A majority of these feeds was a mixture of hominy feed, corn feed meal, and ground oat meal mill by-products with small amounts of salt added. Others consisted of mixtures of rolled or crushed corn, oats and barley.

Results of analysis on 48 samples of molasses horse feeds are tabulated. One sample (2.1%) was deficient in protein; all were equal to guarantee in fat; and 4 (8.3%) contained an excess of crude fiber. With but few exceptions alfalfa meal is the base of these feeds with some grain, usually corn and oats, and molasses added. The price is not far different from that of the horse feeds previously mentioned, being from \$51 to \$66 per ton.

POULTRY FEEDS.

Four hundred and five samples of poultry feed were analyzed of which 333 were scratch feeds, chick feeds and pigeon feeds; and 72 were mash feeds. Of the total number 2.2% were below guarantee in protein; 2.5% in fat; and 2.5% were above in crude fiber. Many of the apparent deficiencies were due to unwise guarantees rather than poor quality of the feed. The average analysis of poultry feeds, other than the mashes, was found to be as follows: protein 10.5%, fat 3.0%, fiber 3.2%. When compared with the usual guarantee of 10% protein, 2.5% fat, and 5 % fiber which is used by most of the larger manufacturers it is observed that a safe margin for variation is allowed. Poultry feeds sold under this guarantee rarely show a deficiency.

The average analysis and price of poultry feeds, other than mashes, containing no grit were compared with similar figures for feeds containing grit to determine which class of feed represented the more economical purchase. The average analysis of 211 samples without grit was found to be 10.5% protein, 3.0% fat and 3.8% fiber; the average of 57 samples containing grit was 10.1% protein, 3% fat and 3.5% fiber. The "no grit" feeds sold at an average price of \$3.99 per cwt. and the "with grit" at \$3.76 per cwt., a difference of 23 cents. Assuming an estimated grit content of 5% the average analysis of the latter class on a grit free basis would be 10.6%, 3.2% and 3.7% for protein, fat and fiber respectively which corresponds closely to that of feeds with no grit. It is seen then that the reduction of 23 cents in the price of feeds containing

grit represents the value of the 5 pounds of grain in each 100 pounds of feed which has been replaced with grit. Putting a value of 1 cent per pound on grit it is found that the price on a grit free basis of feeds containing this material would be \$3.91 per cwt. From the past year's figures it would appear that there is practically no difference in the actual purchase prices of grains whether a feed does or does not contain grit. However, purchasers are advised to investigate the price of both classes of feeds before buying as local prices often vary widely from the average.

CORN AND OAT FEEDS.

Most of the feeds in this class are composed largely of corn feed meal mixed with oat meal mill by-products with oats sometimes added. The analyses of the 28 samples collected show 2 or 7.1% below guarantee in protein, 9 or 32.1% low in fat, and 12 or 42.9% high in fiber. Here again the variation is largely due to unwise guarantees.

WHEAT BRAN.

The action of the Federal Food Administration in putting a low fixed price on wheat mill feeds brought them on the market in unusual quantities. During the present year 122 samples of wheat bran were collected as compared with 49 samples last year. Only 4 samples were below guarantee in protein and all were equal to guarantee for fat. Ten (8.2%) contained fiber in excess of the guarantee.

Wheat brans containing no ground screenings are not included in this class as the pure product does not require registration and consequently but few of the pure brans analyzed were guaranteed. The same is true of wheat middlings and wheat mixed feed.

WHEAT MIDDLINGS.

One hundred fifteen samples of wheat middlings were analyzed during the year. Of this number one sample was low in protein, seven in fat and nine high in fiber. Both standard and flour middlings are included in the list. The average analysis was found to be 16.9% protein, 5.1% fat and 7.5% crude fiber. Prices were found to vary from \$34.66 to \$60.00 per ton. The first was the government price in bulk at the mill and the latter the highest price found after restrictions had been removed.

WHEAT MIXED FEED.

Wheat mixed feed or shipstuf is the mixture of wheat bran and middlings as it comes from the mill in the manufacture of flour. Nineteen samples of such feed were drawn and all were found to be equal to guarantee in every respect.

WHEAT AND RYE MIXED FEEDS.

Eight samples were analyzed and all found to conform to guarantee except one which was high in fiber content. These feeds consisted of a mixture of wheat and rye middlings with ground screenings.

RYE FEED.

Rye feed corresponds to, and is derived in the same manner from rye as wheat mixed feed is derived from wheat. The average analysis of the eight samples collected was found to be 15.6% protein, 3.5% fat and 5.4% fiber. Four samples were below guarantee in protein and one was above in crude fiber.

OAT MEAL MILL BY- PRODUCTS.

Analyses of 14 oat feeds are tabulated and there is shown one deficiency each in protein and fat with two samples having an excess of fiber. Of the 14 feeds, 9 were the ground entire by-product consisting of oat hulls, oat shorts and oat middlings; five were ground oat hulls alone. The average analysis shown in the table of summaries is 6.0% protein, 1.9% fat and 27.4% crude fiber. The average selling price was \$30.38.

As is pointed out in a previous paragraph, about 90% of this by-product feed is oat hulls. In view of the fact that the 54% of the total dry matter in oat hulls is digestible, the feed has unquestionably low feeding value. Henry & Morrison give the value of oat hulls as, "only little, if any above that of oat straw." Few feeders would pay thirty dollars per ton for ground oat straw.

BARLEY FEED.

Six samples were analyzed one of which was below guarantee in protein and one contained an excess of fiber. Uniformity in the composition of the various samples was lacking; one sample was pure barley hulls; two were barley hulls with barley screenings; and three were a mixture of the hulls, bran, middlings and screenings. The last mentioned is the true barley mill feed with screenings or barley mixed feed with screenings and is the only sort which should be so labelled. Any other barley by-product should be so named as to designate its true composition.

CEREAL FOOD BY-PRODUCTS.

Of the 27 samples of this class of feed one is deficient in protein and one in fat. A great variety of products is found in this class with a similar variety of guarantees.

MISCELLANEOUS FEEDS.

Under this heading are included two samples of peanut bran, two of pea bean, one of wheat screenings, a sample of ground flaxseed screenings and grain screenings, and one condimental stock food. None were deficient in protein or fat and but one exceeded the guarantee percentage of fiber.

SUMMARY OF INSPECTION.

Feeds.	Number of samples analyzed.	Protein.				Fat.			Crude Fiber.		
		Average per cent.	Deficient.		Average per cent.	Deficient.		Average per cent.	Excess.		
			No.	Per cent.		No.	Per cent.		No.	Per cent.	
Cottonseed Meal.....	143	37.5	21	14.7	6.4	1	0.7	13.4	20	11.0	
Cottonseed Feed.....	11	20.2	0	0.0	3.7	0	0.0	12.8	0	0.0	
Linseed Meal.....	69	34.9	0	0.0	6.7	0	0.0	7.8	0	0.0	
Distillers Grains.....	1	32.6	0	0.0	8.0	1	100.0	11.2	0	0.0	
Yeast and Vinegar Grains.....	2	19.0	0	0.0	6.0	0	0.0	15.0	0	0.0	
Malt Grains.....	5	29.8	0	0.0	5.9	0	0.0	11.1	0	0.0	
Gluten Feed.....	18	23.3	5	27.7	4.0	0	0.0	7.0	0	0.0	
Hominy Feed.....	9	10.3	1	11.1	6.2	0	0.0	4.0	0	0.0	
Corn Germ Meal.....	6	20.7	1	16.6	10.2	0	0.0	9.2	0	0.0	
Corn Feed Meal.....	13	9.4	3	23.1	5.1	4	30.8	3.6	0	0.0	
Animal By-Products.....	27	53.5	1	11.8	9.0	0	0.0	2.1	1	3.7	
Dried Beet Pulp.....	7	8.8	0	0.0	0.9	0	0.0	18.6	0	0.0	
Alfalfa Meal.....	7	11.8	0	0.0	1.5	0	0.0	29.2	0	0.0	
Calf Meals.....	40	23.7	9	22.5	5.2	10	25.0	5.6	6	15.0	
Hog Feeds.....	58	15.9	5	8.6	4.3	3	5.2	7.9	7	12.1	
Dairy Feeds.....	139	21.4	18	13.0	5.0	14	10.1	10.9	17	12.2	
Molasses Dairy Feeds.....	74	19.0	8	10.8	4.5	6	8.1	14.2	13	17.5	
Stock Feeds.....	31	11.2	0	0.0	3.9	5	14.7	10.6	10	29.4	
Molasses Stock Feeds.....	6	10.3	0	0.0	2.8	0	0.0	12.5	0	0.0	
Horse Feeds.....	18	9.4	0	0.0	3.9	0	0.0	7.1	1	5.6	
Molasses Horse Feeds.....	48	10.7	1	2.1	2.8	0	0.0	11.4	1	8.3	
Poultry Mash Feeds.....	72	17.0	5	6.9	4.6	3	4.2	7.5	3	1.2	
Scratch Feeds, Chick Feeds, Pigeon Feeds.....	333	10.5	4	1.2	3.0	7	2.1	31.9	7	2.1	
Corn and Oat Feeds.....	28	9.1	2	7.1	4.4	9	32.1	7.5	12	42.9	
Wheat Bran.....	122	15.2	4	3.3	4.7	0	0.0	10.4	10	8.2	
Wheat Middlings.....	115	16.9	1	0.9	5.1	7	6.1	7.5	9	7.8	
Wheat Mixed Feed.....	19	16.6	0	0.0	4.6	0	0.0	8.2	0	0.0	
Wheat and Rye Mixed Feeds.....	8	16.2	0	0.0	4.1	0	0.0	7.2	1	12.5	
Rye Feed.....	8	15.6	2	25.0	3.5	0	0.0	5.4	1	12.5	
Oat Meal Mill By-Products.....	14	6.0	1	7.1	1.9	1	7.1	27.4	2	14.2	
Barley Feed.....	6	11.1	1	16.7	2.8	0	0.0	15.2	1	16.7	
Cereal Food By-Products.....	27	12.2	0	0.0	2.0	1	3.7	6.9	0	0.0	
Miscellaneous Feeds.....	7	.....	1	14.3	.....	0	0.0	.....	1	14.3	
Feeds requiring no license.....	22	.....	.....	.....	.....	.....	.....	.....	.....	.....
Totals.....	1,530	.....	97	*6.4	.....	72	*4.8	.....	126	*8.4	

*Percentages calculated on 1,508 samples of licensed feeds.

ANALYSES OF FEEDING STUFFS FOR 1915-1919.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton of cwt.
COTTONSEED MEAL.							
American Cotton Oil Co., New York, N. Y.							
B 3350	Surety Brand Cottonseed Meal	Detroit.....	{ G.* F.*	36.0	5.5	14.0	
B 3454	Surety Brand Cottonseed Meal	Zeeland.....	9.7	36.4	6.4	12.2	\$60 00
B 3628	Surety Brand Cottonseed Meal	Detroit.....	7.6	35.6	6.2	15.1	60 25
B 3644	Surety Brand Cottonseed Meal	Detroit.....	8.6	37.9	6.1	13.8	60.25
B 3665	Surety Brand Cottonseed Meal	Lansing.....	8.9	32.8	6.1	17.4	65.00
B 3750	Surety Brand Cottonseed Meal	Lansing.....	8.8	34.3	6.7	15.2	
B 3972	Surety Brand Cottonseed Meal	Clare.....	6.8	34.9	6.8	15.5	66 00
B 4075	Surety Brand Cottonseed Meal	Caro.....	8.8	35.9	5.9	14.4	64.00
B 4110	Surety Brand Cottonseed Meal	Minden City.....	7.3	36.1	5.9	15.2	64 00
B 4232	Surety Brand Cottonseed Meal	Harlem.....	9.2	33.9	6.5	15.5	65 00
B 4285	Surety Brand Cottonseed Meal	Holland.....	7.6	36.7	7.7	14.6	66.00
B 4331	Surety Brand Cottonseed Meal	Sault Ste. Marie.....	8.4	36.1	6.3	14.5	74 00
B 4345	Surety Brand Cottonseed Meal	Marquette.....	8.0	36.2	7.2	11.5	3.40
B 4457	Surety Brand Cottonseed Meal	Grand Ledge.....	7.9	35.9	5.9	15.9	63.50
B 4705	Surety Brand Cottonseed Meal	Oxford.....	9.0	33.9	6.1	14.0	3.40
B 4887	Surety Brand Cottonseed Meal	Harbor Beach.....	9.0	37.0	8.7	11.9	3.75
B 5000	Surety Brand Cottonseed Meal	Romeo.....	8.8	37.0	7.8	13.2	3.50
		Average.....	8.5	35.8	6.6	14.2	
J. E. Bartlett Co., Jackson, Mich.							
B 4002	Farmer Brand Prime Cottonseed Meal	Fowlerville.....	{ G.* F.*	38.6	5.0	18.0	
			7.5	39.9	7.1	11.4	
B 3194	Farmer Brand Straight Cottonseed Meal	Grand Rapids.....	{ G.* F.*	36.0	5.0	17.0	
B 3627	Farmer Brand Straight Cottonseed Meal	Ortonville.....	8.6	36.4	7.3	10.5	
B 3899	Farmer Brand Straight Cottonseed Meal	Coopersville.....	8.3	31.5	5.9	17.3	60 60
B 3932	Farmer Brand Straight Cottonseed Meal	Ionia.....	8.5	36.8	7.3	11.3	63 00
B 3983	Farmer Brand Straight Cottonseed Meal	Mulliken.....	9.5	30.2	5.9	17.6	62 00
B 3994	Farmer Brand Straight Cottonseed Meal	Eaton Rapids.....	9.6	35.6	7.2	11.1	66.00
B 4059	Farmer Brand Straight Cottonseed Meal	Bay City.....	8.9	37.1	7.7	11.5	
B 4147	Farmer Brand Straight Cottonseed Meal	Bay City.....	8.6	35.3	6.4	13.8	65.00
B 4213	Farmer Brand Straight Cottonseed Meal	Brown City.....	8.8	34.9	6.2	14.8	3.05
B 4405	Farmer Brand Straight Cottonseed Meal	Three Oaks.....	8.7	37.7	7.4	13.7	
B 4460	Farmer Brand Straight Cottonseed Meal	Clinton.....	9.2	38.6	6.3	13.0	64 00
B 4466	Farmer Brand Straight Cottonseed Meal	Grand Ledge.....	8.6	36.6	5.9	13.1	63.50
B 4480	Farmer Brand Straight Cottonseed Meal	Holly.....	8.8	38.6	5.9	13.0	3.25
B 4805	Farmer Brand Straight Cottonseed Meal	Petoskey.....	7.4	37.4	6.1	14.3	3.50
B 3889	Farmer Brand Straight Cottonseed Meal	Elm.....	8.3	37.6	6.3	13.3	65.00
B 4907	Farmer Brand Straight Cottonseed Meal	Denton.....	8.1	41.0	7.2	11.2	3.25
B 4912	Farmer Brand Straight Cottonseed Meal	Wayne.....	8.7	35.9	5.9	14.3	
B 4921	Farmer Brand Straight Cottonseed Meal	Plymouth.....	7.7	37.7	7.1	12.1	
B 4925	Farmer Brand Straight Cottonseed Meal	Milford.....	8.4	38.8	7.6	11.8	64.00
B 4931	Farmer Brand Straight Cottonseed Meal	Pontiac.....	8.2	36.4	6.3	14.7	66.50
B 4962	Farmer Brand Straight Cottonseed Meal	Port Huron.....	7.6	38.3	8.4	13.3	65.00
		Average.....	8.5	36.6	6.7	13.3	
F. W. Brode & Co., Memphis, Tenn.							
B 4455	Owl Brand H. G. Cottonseed Meal	Caro.....	{ G.* F.*	41.0	6.0	10.0	
B 4456	Owl Brand H. G. Cottonseed Meal	Caro.....	7.9	40.4	6.7	11.0	69.00
			8.2	36.5	7.0	15.5	69.00
		Average.....	8.1	38.5	6.9	13.3	
B 4209	Dove Brand Prime Cottonseed Meal	Niles.....	{ G.* F.*	58.6	6.0	10.0	
B 4255	Dove Brand Prime Cottonseed Meal	Sparta.....	8.0	37.5	6.7	14.2	68 00
B 4829	Dove Brand Prime Cottonseed Meal	Traverse City.....	8.6	39.5	6.2	12.9	65.00
			9.2	37.6	7.6	10.9	3.50
		Average.....	8.6	38.2	6.8	12.6	
B 3186	Jay Brand Cottonseed Meal	Marshall.....	{ G.* F.*	36.0	5.0	14.0	
B 4010	Jay Brand Cottonseed Meal	Saginaw.....	9.1	36.3	7.8	11.6	50 00
B 4287	Jay Brand Cottonseed Meal	Holland.....	8.3	35.8	6.3	15.1	3.30
B 4454	Jay Brand Cottonseed Meal	Alpena.....	8.3	37.9	6.5	13.5	66 00
B 3683	Jay Brand Cottonseed Meal	Zeeland.....	8.7	33.0	6.8	16.3	67.00
B 1811	Jay Brand Cottonseed Meal	Zeeland.....	8.8	36.0	6.5	14.7	65.00
B 1899	Jay Brand Cottonseed Meal	Traverse City.....	8.3	35.2	6.0	13.8	3.40
		Flat Rock.....	9.4	37.4	6.9	12.7	3.40

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or evt.
F. W. Brode & Co., Memphis, Tenn.—Con.							
B 4946	Jay Brand Cottonseed Meal.....	Grand Blaine.....	8.8	36.6	7.4	15.1	\$65.00
B 4022	Jay Brand Cottonseed Meal.....	Coldwater.....	8.9	35.1	5.9	13.2	61.00
B 4554	Jay Brand Cottonseed Meal.....	Menominee.....	8.0	34.5	6.4	13.8	3.75
		Average.....	8.7	35.8	6.7	14.0	.....
Buckeye Cotton Oil Co., Cincinnati, Ohio.							
B 4308	Buckeye Good Cottonseed Meal.....	Twining.....	{ G.* F.*	36.0 34.9	5.0 7.3	14.0 12.6	..... 4.00
B 4414	Buckeye Good Cottonseed Meal.....	Ann Arbor.....	8.7	34.8	6.0	15.0	3.30
B 4441	Buckeye Good Cottonseed Meal.....	Dundee.....	7.5	36.9	5.8	12.8	3.30
B 4710	Buckeye Good Cottonseed Meal.....	Utica.....	7.2	36.8	6.4	12.2	3.30
		Average.....	8.0	35.9	6.4	13.2	.....
S. P. Davis, Little Rock, Ark.							
B 4616	Good Luck Brand Cottonseed Meal.....	Charlevoix.....	{ G.* F.*	41.0 37.0	6.0 7.6	9.0 14.6	..........
B 4103	Beauty Brand Cottonseed Meal.....	Cass City.....	{ G.* F.*	36.0 34.3	6.0 6.0	15.0 13.6	..... 63.50
B 4499	Beauty Brand Cottonseed Meal.....	Ypsilanti.....	8.8	40.3	7.0	12.2	3.30
		Average.....	9.2	37.3	6.5	12.9	.....
Albert Dickinson Co., Chicago, Ill.							
B 4597	Cottonseed Meal.....	Potoskey.....	{ G.* F.*	36.0 35.0	6.0 6.0	14.0 15.6	..... 69.00
B 4741	Cottonseed Meal.....	Hillsdale.....	10.3	38.4	6.9	11.3	3.35
B 4808	Cottonseed Meal.....	Gaylord.....	8.0	34.8	6.3	14.3	3.40
		Average.....	9.0	36.1	6.4	13.7	.....
East St. Louis Cotton Oil Co., National Stock Yards, Ill.							
B 4417	East St. Louis Brand Cottonseed Meal.....	Milan.....	{ G.* F.*	38.5 38.8	6.0 5.6	12.0 13.3	..... 68.50
B 3349	St. Clair Brand Cottonseed Meal.....	Detroit.....	{ G.* F.*	36.0 35.9	5.0 5.9	16.0 12.0	..... 60.00
B 3407	St. Clair Brand Cottonseed Meal.....	Coopersville.....	8.3	37.1	6.4	11.0	55.00
B 3496	St. Clair Brand Cottonseed Meal.....	Zeeland.....	9.3	36.5	6.5	15.3	63.00
B 3748	St. Clair Brand Cottonseed Meal.....	Perry.....	9.5	38.8	6.0	12.0	65.00
B 3759	St. Clair Brand Cottonseed Meal.....	Howell.....	8.7	37.1	6.7	11.2	63.00
B 3872	St. Clair Brand Cottonseed Meal.....	Allegan.....	8.5	38.3	5.5	13.9	65.00
B 3894	St. Clair Brand Cottonseed Meal.....	Muskegon.....	9.0	36.0	5.8	14.5	61.50
B 3902	St. Clair Brand Cottonseed Meal.....	Coopersville.....	9.4	36.0	5.7	13.4	63.00
B 3929	St. Clair Brand Cottonseed Meal.....	Holland.....	8.7	35.2	5.4	14.3	65.00
B 3936	St. Clair Brand Cottonseed Meal.....	Plainwell.....	8.2	36.3	6.5	12.4	60.00
B 3942	St. Clair Brand Cottonseed Meal.....	Kalamazoo.....	8.3	35.8	5.6	12.8	62.00
B 3943	St. Clair Brand Cottonseed Meal.....	Kalamazoo.....	7.8	40.9	6.0	11.6	63.00
B 3963	St. Clair Brand Cottonseed Meal.....	Ithaca.....	7.7	37.0	5.5	13.9	65.00
B 3999	St. Clair Brand Cottonseed Meal.....	Hastings.....	8.6	39.0	6.1	13.1	68.00
B 4005	St. Clair Brand Cottonseed Meal.....	Albion.....	8.0	37.1	5.8	14.8	64.00
B 4023	St. Clair Brand Cottonseed Meal.....	Coldwater.....	8.6	35.9	5.5	13.7	.....
B 4049	St. Clair Brand Cottonseed Meal.....	Saginaw.....	7.6	34.5	6.2	13.9	3.25
B 4121	St. Clair Brand Cottonseed Meal.....	Harbor Beach.....	9.1	36.2	6.0	13.5	63.60
B 4159	St. Clair Brand Cottonseed Meal.....	Hudson.....	8.9	35.4	5.1	14.8	63.00
B 4195	St. Clair Brand Cottonseed Meal.....	Adrian.....	8.5	39.4	6.0	12.2	62.50
B 4272	St. Clair Brand Cottonseed Meal.....	Battle Creek.....	8.7	36.6	5.9	13.9	65.00
B 4278	St. Clair Brand Cottonseed Meal.....	Galesburg.....	9.1	38.7	5.8	11.7	65.00
B 4280	St. Clair Brand Cottonseed Meal.....	Jameson.....	8.1	37.6	5.9	14.4	63.00
B 4291	St. Clair Brand Cottonseed Meal.....	Grandville.....	8.1	37.3	5.7	13.4	65.00
B 4297	St. Clair Brand Cottonseed Meal.....	Coopersville.....	8.7	36.5	6.7	14.3	63.00
B 4298	St. Clair Brand Cottonseed Meal.....	Allegan.....	9.4	36.3	8.5	13.9	64.00
B 4419	St. Clair Brand Cottonseed Meal.....	Morenci.....	8.6	37.4	5.8	14.0	3.25
B 4431	St. Clair Brand Cottonseed Meal.....	Blissfield.....	8.2	38.7	6.5	12.3	.....
B 4449	St. Clair Brand Cottonseed Meal.....	Leslie.....	8.1	37.0	5.6	14.5	3.25
B 4468	St. Clair Brand Cottonseed Meal.....	Flint.....	8.6	37.3	6.3	13.0	66.00
B 4469	St. Clair Brand Cottonseed Meal.....	Flint.....	9.8	35.9	5.7	14.0	66.00
B 4481	St. Clair Brand Cottonseed Meal.....	Flint.....	9.1	36.6	6.3	13.7	66.00
B 4493	St. Clair Brand Cottonseed Meal.....	Ypsilanti.....	9.1	36.3	6.8	11.6	3.35
B 4609	St. Clair Brand Cottonseed Meal.....	Vriesland.....	8.3	36.5	5.9	13.9	65.00
B 4727	St. Clair Brand Cottonseed Meal.....	Trenton.....	8.1	37.1	5.8	14.3	65.00

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
East St. Louis Cotton Oil Co., National Stock Yards, Ill.—Con.							
B 4736	St. Clair Brand Cottonseed Meal	Bronson	8.3	37.8	6.9	11.2	\$3.20
B 4748	St. Clair Brand Cottonseed Meal	Albion	7.4	37.2	7.0	13.8	65 00
B 4894	St. Clair Brand Cottonseed Meal	Wayne	8.7	37.3	6.8	13.9	3 25
B 4897	St. Clair Brand Cottonseed Meal	Belleville	9.1	38.8	6.6	12.5	3 25
B 4906	St. Clair Brand Cottonseed Meal	Denton	8.9	37.5	5.9	13.5	3 25
B 4927	St. Clair Brand Cottonseed Meal	Northville	8.6	35.9	5.7	14.5	64.00
B 4928	St. Clair Brand Cottonseed Meal	Farmington	8.2	40.2	6.2	12.3	65 00
B 4940	St. Clair Brand Cottonseed Meal	Birmingham	8.0	37.4	7.0	13.6	65 00
B 4943	St. Clair Brand Cottonseed Meal	Detroit	8.4	37.5	6.0	13.3	3 30
B 4947	St. Clair Brand Cottonseed Meal	Davison	8.6	36.6	5.7	11.6	63 00
		Average	8.5	37.1	6.1	13.3	...
Hales & Edwards Co., Chicago, Ill.							
B 3471	Cottonseed Meal	Grand Rapids	(G.* F.*	36.0	5.0	12.0	...
B 4577	Cottonseed Meal	Charlevoix	8.5	36.8	7.8	14.4	3 40
B 4810	Cottonseed Meal	Gaylord	8.5	35.7	5.7	12.2	4 00
		Average	8.7	36.3	6.5	12.9	...
Humphreys Godwin Co., Memphis, Tenn.							
B 3916	Forfat Brand Cottonseed Meal	Cashovia	(G.* F.*	38.6 38.3	5.0 6.8	12.0 10.8	62 00
B 4283	Danish Brand Cottonseed Meal	Grand Rapids	(G.* F.*	36.0 35.5	5.0 5.3	15.0 13.9	61 50
B 4557	Danish Brand Cottonseed Meal	Spaulding	8.2	34.3	5.5	13.9	3 70
B 4600	Danish Brand Cottonseed Meal	Potoskey	8.2	35.0	6.4	12.7	3 50
		Average	8.2	34.9	5.7	13.5	...
Imperial Cotto Sales Co., Chicago, Ill.							
B 4319	Imperial Cotto Cottonseed Meal	Cheboygan	(G.* F.*	36.0 35.7	5.0 5.6	14.0 13.0	70 00
C. L. Montgomery Co., Memphis, Tenn.							
B 4243	Star Brand Cottonseed Meal	Big Rapids	(G.* F.*	36.0 40.4	6.0 6.8	14.0 16.3	67 00
B 4291	Star Brand Cottonseed Meal	Coopersville	8.1	37.7	7.0	13.9	63 00
B 4886	Star Brand Cottonseed Meal	Bad Axe	9.8	39.8	8.8	9.9	...
		Average	8.9	39.3	7.5	13.4	...
W. C. Nothern, Little Rock, Ark.							
B 4102	Standard Brand Cottonseed Meal	Cass City	(G.* F.*	36.0 36.8	5.0 5.9	12.0 12.8	69 00
Southern Cotton Oil Co., Little Rock, Ark.							
B 4415	Seoco Brand Cottonseed Meal	Ann Arbor	(G.* F.*	36.0 36.2	5.5 5.5	14.0 17.1	3.30
Wagner White Co., Inc., Jackson, Mich.							
B 3913	Wawco Brand Cottonseed Meal	Belmont	(G.* F.*	36.0 40.9	5.0 8.4	22.0 10.6	65 00
B 3947	Wawco Brand Cottonseed Meal	Williamston	9.2	37.5	7.2	14.3	...
B 4401	Wawco Brand Cottonseed Meal	Tecumseh	9.8	36.9	6.2	12.9	65 50
B 4703	Wawco Brand Cottonseed Meal	Saline	8.5	37.0	6.1	12.5	66 00
B 4713	Wawco Brand Cottonseed Meal	Rockford	8.8	37.2	6.1	12.5	3 40
B 4926	Wawco Brand Cottonseed Meal	Milford	8.8	39.3	7.1	12.4	63 00
B 4966	Wawco Brand Cottonseed Meal	Mt. Clemens	9.0	39.2	6.7	12.0	3 35
B 4971	Wawco Brand Cottonseed Meal	Mt. Clemens	9.1	36.8	5.9	13.3	65 00
B 4981	Wawco Brand Cottonseed Meal	Williamston	8.6	37.0	5.7	12.8	...
		Average	8.9	38.0	6.6	12.6	...
E. L. Wellman, Grand Rapids, Mich.							
B 3795	Feeders Favorite Cottonseed Meal	Hartford	(G.* F.*	36.0 32.4	5.0 5.5	15.0 15.8	64 00
B 3865	Feeders Favorite Cottonseed Meal	Allegan	7.5	37.9	5.6	11.7	65 00
B 3900	Feeders Favorite Cottonseed Meal	Coopersville	9.1	31.4	5.6	15.5	63 00
B 3901	Feeders Favorite Cottonseed Meal	Grand Rapids	8.3	34.8	6.2	16.8	...
B 3909	Feeders Favorite Cottonseed Meal	Hudsonville	9.0	37.2	6.7	13.3	63 00
B 3950	Feeders Favorite Cottonseed Meal	Belding	8.0	37.2	5.8	12.8	...

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
E. L. Wellman, Grand Rapids, Mich.—Con.							
B 3982	Feeders Favorite Cottonseed Meal	Grand Rapids	9.4	37.1	6.7	12.6	\$67.00
B 3985	Feeders Favorite Cottonseed Meal	Lake Odessa	8.9	37.3	5.8	11.7	68.00
B 4239	Feeders Favorite Cottonseed Meal	Cadillac	7.1	39.6	7.3	12.7	66.00
B 4282	Feeders Favorite Cottonseed Meal	Grand Rapids	6.5	38.3	6.1	14.0	65.00
B 4572	Feeders Favorite Cottonseed Meal	Charlevoix	8.5	37.4	6.6	14.1	68.00
B 4813	Feeders Favorite Cottonseed Meal	Boyer City	7.2	42.0	6.5	11.7	3.70
	Average		8.2	36.9	6.2	13.6	
COTTONSEED FEED.							
American Cotton Oil Co., New York City, N. Y.							
B 3195	Columbia Cottonseed Feed	Grand Rapids	G.* F.* 10.7	20.5 21.1	3.0 4.2	25.0 20.6	50.00
B 4588	Columbia Cottonseed Feed	East Jordan		10.1	19.9	4.3	21.8
	Average		10.4	20.5	4.3	21.2	
J. E. Bartlett Co., Jackson, Mich.							
B 4463	Bartlett's Cottonseed Feed Meal	Durand	G.* F.* 9.8	20.0 21.4	3.0 4.3	26.0 23.1	55.00
Hayes Grain & Commission Co., Little Rock, Ark.							
B 3498	Uncle Joe Brand Cottonseed Feed	Zeeland	G.* F.* 10.0	20.0 20.6	3.0 3.0	23.0 23.4	54.00
Humphreys Gidwin Co., Memphis, Tenn.							
B 3196	77 Cottonseed Feed	Grand Rapids	G.* F.* 10.1	20.0 20.2	4.0 3.8	28.0 21.8	50.00
B 3837	77 Cottonseed Feed	Wayland		8.9	19.7	3.9	21.7
B 4284	77 Cottonseed Feed	Grand Rapids		9.2	19.8	3.9	22.9
	Average		9.4	19.9	3.9	22.1	
Imperial Cotto Sales Co., Chicago, Ill.							
B 4318	Cottolene Brand Cottonseed Feed Meal	Chelsoygan	G.* F.* 7.9	20.0 19.8	3.3 3.0	25.0 23.4	60.00
Memphis Cotton Hull & Fiber Co., Memphis, Tenn.							
B 4459	Cyclone Cottonseed Feed	Grand Ledge	G.* F.* 9.0	20.0 20.5	3.0 3.5	26.0 23.8	50.00
B 4929	Cyclone Cottonseed Feed	Farmington		8.5	20.0	3.7	24.2
	Average		8.8	20.3	3.6	24.0	
C. L. Montgomery & Co., Memphis, Tenn.							
B 3686	Globe Brand Cottonseed Feed	Lansing	G.* F.* 9.9	20.0 19.1	3.5 3.2	27.0 24.1	2.75
LINSEED MEAL.							
American Linseed Co., Chicago, Ill.							
B 3707	Old Process Linseed Oil Meal	St. Johns	G.* F.* 9.5	34.0 34.1	6.0 7.3	9.0 7.5	3.25
B 4001	Old Process Linseed Oil Meal	Fowlerville		9.7	37.3	5.6	7.2
B 4214	Old Process Linseed Oil Meal	Three Oaks		9.4	36.4	6.0	8.3
	Average		9.5	35.9	6.3	7.7	
American Milling Co., Peoria, Ill.							
B 3191	Amco Old Process Linseed Meal and Old Process Screenings Oil Feed	Grand Rapids	G.* F.* 9.5	30.0 31.7	5.0 6.5	10.0 8.7	
B 3477	Amco Old Process Linseed Meal and Old Process Screenings Oil Feed	Comstock Park		9.9	30.7	6.3	9.5
B 3585	Amco Old Process Linseed Meal and Old Process Screenings Oil Feed	Albion		10.0	31.9	6.7	9.0
B 2845	Amco Old Process Linseed Meal and Old Process Screenings Oil Feed	Belmont		10.1	30.3	6.7	8.9

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1913-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
American Milling Co. Peoria Ill.—Con.							
B 4392	Amco Old Process Linseed Meal and Old Process Screenings Oil Feed	Ewen	9.8	30.9	7.3	9.1	\$4.75
B 4567	Amco Old Process Linseed Meal and Old Process Screenings Oil Feed	Trout Lake	8.7	31.1	7.1	9.5	4.25
B 4568	Amco Old Process Linseed Meal and Old Process Screenings Oil Feed	Charlevoix	9.5	32.6	6.6	8.8	3.70
		Average	9.6	31.3	6.7	9.1	.....
Archer Daniels Linseed Co. Minneapolis Minn.							
B 4368	Old Process Ground Linseed Cake	Chassell	{ G.* F.*	33.0 36.9	6.0 7.6	10.0 7.7	..... 4.00
B 4386	Old Process Ground Linseed Cake	Ontonagon		34.9	6.9	8.3	4.00
B 4709	Old Process Ground Linseed Cake	Utica		35.0	7.6	8.0	3.75
		Average	9.5	35.6	7.4	8.0	.....
Chicago Heights Oil Mfg. Co. Chicago Ill.							
B 3366	Old Process Laxo Cake Meal	Detroit	{ G.* F.*	25.0 28.2	6.0 7.4	12.0 4.6	..... 60.00
B 3898	Old Process Laxo Cake Meal	Muskegon		29.3	7.6	9.1	60.00
		Average	9.6	28.8	7.5	6.9	.....
Wm. O. Goodrich Co. Milwaukee Wis.							
B 3813	Old Process Ground Linseed Cake	Holland	{ G.* F.*	32.0 34.3	5.0 7.9	10.0 8.3	..... 63.00
B 4831	Old Process Ground Linseed Cake	Traverse City		33.9	7.1	7.8	3.50
		Average	9.6	34.1	7.5	8.1	.....
Hirst & Begley Linseed Co., Chicago, Ill.							
B 3168	Linseed Oil Meal	Grand Rapids	{ G.* F.*	34.0 37.8	6.0 6.3	9.0 7.6	..........
B 3430	Linseed Oil Meal	Grand Haven		35.4	6.5	8.0	67.00
B 3438	Linseed Oil Meal	Jamestown		34.3	5.9	8.0	62.00
B 3442	Linseed Oil Meal	Jamestown		36.8	6.8	7.0	62.00
B 3467	Linseed Oil Meal	Zeeland		36.3	5.8	7.7	65.00
B 3715	Linseed Oil Meal	Owosso		36.8	6.4	7.8	3.35
B 3823	Linseed Oil Meal	Holland		33.6	7.3	7.4	64.00
B 4228	Linseed Oil Meal	Hudsonville		35.1	6.7	8.2	70.00
B 4229	Linseed Oil Meal	Holland		34.3	7.1	9.4	75.00
B 4231	Linseed Oil Meal	Harlem		35.1	6.7	8.0	70.00
B 4233	Linseed Oil Meal	Muskegon		36.1	6.6	8.7	75.00
B 4824	Linseed Oil Meal	Kalkaska		36.6	6.3	8.2	3.90
		Average	8.5	35.4	6.5	8.0	.....
Spencer Kellogg & Sons, Buffalo, N. Y.							
B 3351	Pure Old Process Oil Meal	Sparta	{ G.* F.*	33.0 34.8	5.0 6.4	10.0 8.3	..... 70.00
B 4230	Pure Old Process Oil Meal	Holland		34.7	6.4	8.7	75.00
B 4286	Pure Old Process Oil Meal	Holland		35.9	6.2	7.9	74.00
B 4578	Pure Old Process Oil Meal	Charlevoix		38.7	5.5	7.2	3.70
B 4744	Pure Old Process Oil Meal	Hillsdale		35.3	5.6	6.8	3.65
B 4934	Pure Old Process Oil Meal	Pontiac		37.8	5.8	7.4	70.00
		Average	9.4	36.2	6.0	7.7	.....
Metzger Seed & Oil Co., Toledo, Ohio.							
B 3601	Old Process Oil Meal	Allion	{ G.* F.*	30.0 31.5	5.0 6.7	10.0 7.6	..... 3.25
B 3675	Old Process Oil Meal	Lansing		31.4	6.4	7.8	3.50
B 3835	Old Process Oil Meal	Moline		36.9	6.8	7.5	64.00
B 4026	Old Process Oil Meal	Saginaw		35.8	6.5	7.7	61.00
B 4064	Old Process Oil Meal	Bay City		32.1	7.0	8.1	3.50
B 4098	Old Process Oil Meal	Cass City		33.6	7.0	8.2	74.00
B 4245	Old Process Oil Meal	Big Rapids		35.8	7.5	7.9	78.00
B 4314	Old Process Oil Meal	Alpena		36.9	7.3	7.7	4.10
		Average	9.8	35.0	6.9	7.7	.....

*Abbreviations for Guaranteed and Found.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
	Midland Linseed Products Co., Minneapolis, Minn.						
B 3183	Argentine Brand Pure Old Process Ground Linseed Cake	Coopersville. { <i>G.*</i> <i>F.*</i>	30.0 9.1	5.0 34.6	9.5 7.6	7.3	860.00
B 3495	Argentine Brand Pure Old Process Ground Linseed Cake	Janestown.	9.1	34.5	9.4	7.7	
B 3588	Argentine Brand Pure Old Process Ground Linseed Cake	Albion.	9.0	35.9	8.7	7.0	65.00
B 3917	Argentine Brand Pure Old Process Ground Linseed Cake	Casnovia.	9.1	34.6	7.5	7.5	64.00
B 4875	Argentine Brand Pure Old Process Ground Linseed Cake	Ludington.	9.0	35.2	8.0	7.0	4.25
		Average.	9.1	35.0	8.2	7.3	
B 3825	Midland Brand Pure Old Process Ground Linseed Cake	Holland. { <i>G.*</i> <i>F.*</i>	32.0 9.3	5.0 33.9	9.5 8.1	8.2	61.00
B 3878	Midland Brand Pure Old Process Ground Linseed Cake	Muskegon.	9.2	33.4	8.5	7.4	
B 4344	Midland Brand Pure Old Process Ground Linseed Cake	Munising.	8.2	36.4	8.0	7.3	3.50
B 4575	Midland Brand Pure Old Process Ground Linseed Cake	Charlevoix.	8.8	36.9	7.5	8.0	70.00
		Average.	8.9	35.2	8.0	7.7	
	Minnesota Linseed Oil Co., Minneapolis, Minn.						
B 4347	Old Process Ground Linseed Cake	Marquette. { <i>G.*</i> <i>F.*</i>	34.0 9.1	5.0 36.3	11.0 6.1	8.5	3.50
	Sherwin-Williams Co., Cleveland, Ohio.						
B 4011	SWC Linseed Oil Meal	Coldwater. { <i>G.*</i> <i>F.*</i>	32.0 8.7	5.0 35.4	8.0 6.0	8.0 7.4	3.50
B 3914	SWC Linseed Oil Meal	Sparta.	9.2	37.0	5.8	7.8	
B 4175	SWC Linseed Oil Meal	Hillsdale.	9.2	34.9	6.5	7.4	3.75
B 4273	SWC Linseed Oil Meal	Battle Creek.	9.7	36.9	6.1	7.6	68.00
B 4898	SWC Linseed Oil Meal	Belleville.	9.7	38.7	6.1	8.4	3.75
B 4984	SWC Linseed Oil Meal	Jackson.	9.4	37.4	5.7	8.3	70.00
		Average.	9.3	36.7	6.0	7.8	
	Toledo Seed & Oil Co., Toledo, Ohio.						
B 3381	Major Brand Old Process Oil Meal	Detroit. { <i>G.*</i> <i>F.*</i>	32.0 10.0	6.0 34.5	10.0 6.4	10.0 6.9	60.00
B 3532	Major Brand Old Process Oil Meal	Detroit.	9.1	33.1	6.1	7.2	62.00
B 3591	Major Brand Old Process Oil Meal	Albion.	9.3	37.8	6.2	7.1	65.00
B 3606	Major Brand Old Process Oil Meal	Marshall.	9.8	35.6	6.8	7.4	68.00
B 3638	Major Brand Old Process Oil Meal	Detroit.	9.2	36.1	6.1	6.9	
B 3840	Major Brand Old Process Oil Meal	Wayland.	9.8	36.9	6.2	7.4	67.00
B 3934	Major Brand Old Process Oil Meal	Plainwell.	9.2	36.0	5.5	7.4	65.00
B 3941	Major Brand Old Process Oil Meal	Kalamazoo.	9.8	35.1	5.5	6.8	69.00
B 4056	Major Brand Old Process Oil Meal	Bay City.	8.9	35.3	6.6	7.1	66.00
B 4253	Major Brand Old Process Oil Meal	Grand Rapids.	9.2	34.8	6.1	8.8	68.00
		Average.	9.4	35.5	6.2	7.3	
	DISTILLER'S DRIED GRAINS.						
	American Milling Co., Peoria, Ill.						
B 3348	Empire Dairy Feed	Detroit. { <i>G.*</i> <i>F.*</i>	30.0 7.1	10.0 32.6	11.0 8.0	11.0 11.2	60.00
	YEAST AND VINEGAR GRAINS AND DRIED MALT GRAINS.						
	Cleveland Grains Drying Co., Cleveland, Ohio.						
B 4437	Atlantic Grains Yeast & Vinegar Grains	Monroe. { <i>G.*</i> <i>F.*</i>	19.0 5.6	6.0 19.1	18.0 7.4	18.0 18.5	51.00

*Abbreviations for Guaranteed and Found L.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Kellogg Toasted Corn Flake Co., Battle Creek, Mich.							
		(1918) { <i>G.*</i>	25.1	5.1	12.7	.....
B 3404	Malt Feed.....	Coopersville..... { <i>F.*</i>	8.3	30.1	6.1	12.1	\$52.00
B 3444	Malt Feed.....	Jamestown.....	8.7	29.8	6.2	11.4	55.00
B 3463	Malt Feed.....	Zeeland.....	8.1	30.7	5.6	9.8	54.00
B 3492	Malt Feed.....	Vriesland.....	9.0	29.5	5.7	11.5	52.00
		Average.....	8.5	30.0	5.9	11.2	.....
		(1919) { <i>G.*</i>	26.0	5.2	12.5	.....
B 4267	Malt Feed.....	Battle Creek..... { <i>F.*</i>	4.7	28.1	5.8	10.9	.....
Quaker Oats Co., Chicago, Ill.							
B 4188	Dried Malt By-Product.....	Hudson..... { <i>G.*</i>	18.0	5.0	14.0	.....
		..... { <i>F.*</i>	6.9	18.9	4.6	11.5	55.00
CORN GLUTEN FEED.							
Corn Products Refining Co., New York City, N. Y.							
		(<i>G.*</i>	23.0	1.0	8.5	.....
B 3525	Buffalo Corn Gluten Feed.....	Detroit..... { <i>F.*</i>	9.0	25.5	3.0	7.2	62.00
B 3630	Buffalo Corn Gluten Feed.....	Detroit.....	8.9	23.9	3.6	7.3	56.00
B 3667	Buffalo Corn Gluten Feed.....	Lansing.....	7.3	25.8	4.4	8.1	58.00
B 3687	Buffalo Corn Gluten Feed.....	Lansing.....	9.4	26.4	2.6	6.7	3.25
B 3739	Buffalo Corn Gluten Feed.....	Mason.....	10.3	24.4	3.3	6.8	60.00
B 3866	Buffalo Corn Gluten Feed.....	Allagan.....	13.9	24.7	2.6	8.6	65.00
		Average.....	9.8	25.1	3.3	7.5	.....
Douglas Company, Cedar Rapids, Ia.							
		(<i>G.*</i>	23.0	1.0	8.0	.....
B 4363	Douglas Corn Gluten Feed.....	Ishpeming..... { <i>F.*</i>	9.5	23.2	2.2	6.8	70.00
B 4782	Douglas Corn Gluten Feed.....	Saline.....	8.2	30.7	3.2	6.5	3.75
B 4850	Douglas Corn Gluten Feed.....	Frankfort.....	8.9	22.7	2.5	7.0	3.50
		Average.....	8.9	25.5	2.6	6.8	.....
J. C. Hubinger Bros. Co., Keokuk, Iowa.							
		(<i>G.*</i>	23.0	2.4	7.5	.....
B 3414	KKK Corn Gluten Feed.....	Grand Rapids..... { <i>F.*</i>	8.4	22.7	2.6	7.0	65.00
B 3883	KKK Corn Gluten Feed.....	Muskegon.....	7.9	19.8	6.2	6.8	65.00
B 4438	KKK Corn Gluten Feed.....	Monroe.....	8.0	22.4	7.1	7.2	.....
B 4498	KKK Corn Gluten Feed.....	Ypsilanti.....	8.5	21.8	7.5	6.5	3.20
		Average.....	8.2	21.7	5.9	6.9	.....
Huron Milling Co., Harbor Beach, Mich.							
		(<i>G.*</i>	22.0	3.0	8.0	.....
B 4086	Jenks Corn Gluten Feed.....	Bad Axe..... { <i>F.*</i>	8.6	21.3	3.3	6.3	3.00
B 4425	Jenks Corn Gluten Feed.....	Harbor Beach.....	10.6	24.5	5.6	6.0	53.75
B 4434	Jenks Corn Gluten Feed.....	Croswell.....	8.8	17.6	4.2	7.9	3.00
B 4316	Jenks Corn Gluten Feed.....	Alpena.....	8.4	19.3	3.7	5.9	68.00
B 4957	Jenks Corn Gluten Feed.....	Port Huron.....	7.8	20.8	4.8	7.4	3.50
		Average.....	8.8	20.7	4.3	6.7	.....
HOMINY FEED.							
American Hominy Co., Indianapolis, Ind.							
		(<i>G.*</i>	10.0	6.0	6.0	.....
B 4737	Honco Hominy Feed.....	Bronson..... { <i>F.*</i>	9.9	10.4	5.9	3.4	.....
Beck Cereal Co., Detroit, Mich.							
		(<i>G.*</i>	10.0	6.0	6.0	.....
B 3336	Royal Yellow Hominy Feed Meal.....	Detroit..... { <i>F.*</i>	14.6	10.1	5.9	3.6	60.00
B 3626	Royal Yellow Hominy Feed Meal.....	Detroit.....	11.3	8.9	6.0	3.4	56.00
		Average.....	13.0	9.5	6.0	3.5	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Chas. A. Krause Milling Co., Milwaukee, Wis.							
B 3455	Badger Hominy Feed	Zeeland..... { G.*	10.9	10.7	6.3	4.3	866.00
B 3711	Badger Hominy Feed	St. Johns..... { F.*	9.9	10.5	5.6	2.1	58.00
B 4346	Badger Hominy Feed	Marquette..... {	9.7	10.9	6.3	4.3	3.35
		Average..... {	10.2	10.7	6.1	3.6	
Marshall Milling Co., Marshall, Minn.							
B 3869	Hominy Feed	Allegan..... { G.*	9.6	10.9	5.0	7.0	60.00
		..... { F.*		10.8	7.5	6.7	
Postum Cereal Co., Battle Creek, Mich.							
B 4264	Burt's Hominy Feed	Battle Creek..... { G.*	9.7	10.0	6.0	5.0	
		..... { F.*		10.6	5.8	3.3	
United States Frumentum Co., Detroit, Mich.							
B 3664	Frumentum Hominy Feed	Detroit..... { G.*	8.7	10.5	6.0	7.0	53.50
		..... { F.*		10.0	6.2	4.5	
CORN GERM MEAL.							
Corn Products Refining Co., New York City, N. Y.							
B 3639	Diamond Hog Meal	Detroit..... { G.*	9.6	18.0	7.0	13.0	62.00
B 4193	Diamond Hog Meal	Adrian..... { F.*	10.9	23.7	10.0	9.4	65.00
B 4299	Diamond Hog Meal	Allegan..... {	10.6	22.0	10.0	8.6	60.00
B 4558	Diamond Hog Meal	Spaulding..... {	8.5	20.1	9.7	8.9	64.00
B 4610	Diamond Hog Meal	Vriesland..... {	7.5	23.0	8.7	9.0	60.00
B 4913	Diamond Hog Meal	Plymouth..... {	8.1	20.6	11.9	9.5	3.00
		Average..... {	9.2	20.7	10.2	9.2	
CORN FEED MEAL.							
Ferdinand Becker, Grand Rapids, Mich.							
B 4614	Feed Corn Meal	Grand Rapids..... { G.*	11.4	9.0	4.0	9.0	72.00
		..... { F.*		9.2	4.2	2.6	
Darrah Milling Co., Big Rapids, Mich.							
B 4217	Unbolted Corn Meal	Big Rapids..... { G.*	15.3	5.0	4.0	3.5	56.00
		..... { F.*		8.6	3.5	1.7	
King Milling Co., Lowell, Mich.							
B 4256	King Corn Meal	Lowell..... { G.*	15.9	10.1	7.5	4.2	
		..... { F.*		8.6	3.6	1.4	
Saginaw Milling Co., Saginaw, Mich.							
B 4041	Saginaw Corn Feed	Saginaw..... { G.*	11.4	10.0	6.0	7.0	2.30
B 4132	Saginaw Corn Feed	Croswell..... { F.*	14.6	10.1	6.7	3.7	50.00
B 4148	Saginaw Corn Feed	Mayville..... {	11.5	10.5	5.7	4.6	
		Average..... {	12.5	10.6	6.6	3.7	
David Stott Flour Mills, Detroit, Mich.							
B 4415	Corn Feed Meal	Adrian..... { G.*	9.9	10.0	6.0	5.0	60.00
		..... { F.*		10.4	5.7	4.3	
Valley City Milling Co., Grand Rapids, Mich.							
B 3798	Rowena Coarse Corn Meal	Hartford..... { G.*	11.0	11.1	8.8	4.0	60.00
B 3863	Rowena Coarse Corn Meal	Grand Rapids..... { F.*	12.3	9.9	7.7	4.4	48.00
		Average..... {	11.7	10.5	8.3	4.2	
Washburn Crosby Co., Minneapolis, Minn.							
B 3884	Corn Feed Meal	Muskegon..... { G.*	10.2	8.0	5.0	10.0	62.00
		..... { F.*		10.2	7.1	6.6	

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Watson Higgins Milling Co., Grand Rapids, Mich.							
		(1918) { <i>G.*</i>	10.5	8.0	7.0		
B 3199	Corn Feed.....	Grand Rapids... { <i>F.*</i>	12.4	9.6	3.2	3.7	\$53.00
B 3857	Corn Feed.....	Wayland	11.9	8.9	3.7	3.1	58.50
B 3910	Corn Feed.....	Grand Rapids.....	11.7	9.0	3.3	4.0	57.00
		Average	12.0	9.2	3.4	3.6	
ANIMAL BY-PRODUCTS.							
Chicago Feed & Fertilizer Co., Chicago, Ill.							
B 4172	Magie Brand Digester Tankage.....	Hillsdale..... { <i>G.*</i>	60.0	2.0	3.0		
		{ <i>F.*</i>	7.8	58.4	4.2	0.7	6.00
Darling & Company, Chicago, Ill.							
B 3992	Darling's 60% Digester Tankage.....	Eaton Rapids... { <i>G.*</i>	60.0	0.5	5.0		
		{ <i>F.*</i>	10.1	61.9	5.6	1.7	6.25
B 4740	Darling's Meat Crisps.....	Hillsdale..... { <i>G.*</i>	75.0	0.5	3.0		
		{ <i>F.*</i>	6.3	75.9	8.1	0.4	
B 3453	Darling's Meat Scraps.....	Zeeland	50.0	0.5	3.0		
B 3694	Darling's Meat Scraps.....	Lansing	9.4	51.7	7.6	2.1	5.75
B 3776	Darling's Meat Scraps.....	South Haven.....	9.6	54.1	2.3	2.7	5.75
B 4010	Darling's Meat Scraps.....	Union City.....	7.4	52.5	9.3	6.6	5.75
B 4012	Darling's Meat Scraps.....	Coldwater	7.6	53.6	9.7	5.5	6.00
B 4143	Darling's Meat Scraps.....	Marlette	7.7	55.1	9.6	5.7	5.50
B 4252	Darling's Meat Scraps.....	Grand Rapids.....	8.7	53.3	9.9	5.7	6.00
B 4403	Darling's Meat Scraps.....	Tecumseh	7.1	55.4	8.4	5.5	5.50
B 4804	Darling's Meat Scraps.....	Petoskey.....	8.0	52.8	9.6	3.3	
B 4813	Darling's Meat Scraps.....	Boyne City.....	8.6	55.0	7.1	3.0	7.50
		Average	7.8	55.1	9.3	2.4	6.20
Hartman Tankage Works, Grand Rapids, Mich.							
B 3189	Hartman Tankage.....	Comstock Park.. { <i>G.*</i>	49.2	9.8	0.8		
		{ <i>F.*</i>	6.7	50.8	11.2	0.9	89.00
A. P. Kleise, Holland, Mich.							
B 4643	Tankage.....	Holland	{ <i>G.*</i>	45.0	10.0	0.5	
		{ <i>F.*</i>	4.6	36.3	16.9	1.0	80.00
Millenbach Bros. Co., Detroit, Mich.							
B 3364	Millenbach's Mixed Beef Scraps	Detroit..... { <i>G.*</i>	45.0	10.0			
B 3398	Millenbach's Mixed Beef Scraps	Detroit..... { <i>F.*</i>	7.8	48.7	9.8	2.5	4.06
B 3623	Millenbach's Mixed Beef Scraps	Detroit.....	7.9	56.0	9.8	1.7	4.25
			7.4	49.5	10.2	3.0	5.00
		Average	7.7	51.4	9.9	2.4	
Swift & Company, Chicago, Ill.							
B 3586	Swift's Digester Tankage.....	Albion..... { <i>G.*</i>	60.0	5.0	3.0		
B 3749	Swift's Digester Tankage.....	Perry..... { <i>F.*</i>	8.0	57.8	7.7	0.9	5.00
B 4196	Swift's Digester Tankage.....	Adrian.....	7.2	63.0	9.9	1.6	65.00
B 4618	Swift's Digester Tankage.....	Cassopolis.....	8.6	61.8	10.3	1.7	5.75
			11.3	59.7	8.1	1.8	
		Average	8.8	60.6	9.0	1.5	
B 3695	Swift's Meat Meal.....	Lansing..... { <i>G.*</i>	46.0	4.0	3.0		
		{ <i>F.*</i>	12.0	48.0	6.6	1.9	5.25
B 4197	Swift's Meat Scraps.....	Adrian..... { <i>G.*</i>	50.0	6.0	3.0		
B 4933	Swift's Meat Scraps.....	Pontiac..... { <i>F.*</i>	6.4	50.6	11.1	1.6	5.75
			7.5	55.3	9.6	2.6	5.50
		Average	7.0	53.0	10.4	2.1	
B 3633	Swift's Poultry Bone.....	Detroit..... { <i>G.*</i>	35.0	2.0	3.0		
		{ <i>F.*</i>	6.8	25.2	2.0	3.6	5.50
S. I. Treat & Son, Coldwater, Mich.							
B 4734	Old Hoss Brand Tankage.....	Coldwater..... { <i>G.*</i>	53.0	17.4	0.7		
		{ <i>F.*</i>	3.7	47.7	19.8	2.8	60.00

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
DRIED BEET PULP.							
Larowe Milling Co., Detroit, Mich.							
B 3764	Dried Beet Pulp.....	Howell..... { G.*	9.9	8.0	0.5	20.0	.....
B 3990	Dried Beet Pulp.....	Grand Rapids... { F.*	10.5	8.7	0.9	18.5	.....
B 4035	Dried Beet Pulp.....	Saginaw.....	10.3	8.5	1.2	18.8	\$52.00
B 4187	Dried Beet Pulp.....	Hudson.....	7.6	9.3	0.5	19.4	46.00
B 4250	Dried Beet &ulp.....	Grand Rapids...	9.4	9.1	0.9	18.5	55.00
		Average.....	9.6	8.9	0.9	18.9	46.00
Michigan Sugar Co., Saginaw, Mich.							
B 4015	Dried Beet Pulp.....	Coldwater..... { G.*	9.3	8.0	0.5	20.0	.....
B 4985	Dried Beet Pulp.....	Jackson..... { F.*	9.4	8.3	0.9	17.7	2.60
		Average.....	9.4	8.9	0.7	18.2	46.00
ALFALFA MEAL.							
Denver Alfalfa Milling & Products Co., Lamar, Colo.							
B 3817	Alfalfa Meal.....	Holland..... { G.*	9.5	12.0	1.5	35.0	.....
		{ F.*	9.5	16.6	1.9	23.5	56.00
Albert Dickinson Co., Chicago, Ill.							
B 4219	Alfalfa Meal.....	Benton Harbor.. { G.*	7.7	12.0	1.0	35.0	.....
B 4923	Alfalfa Meal.....	Wixom..... { F.*	13.0	14.1	1.6	32.4	2.75
		Average.....	10.4	13.3	1.3	31.6	47.00
Hales & Edwards Co., Chicago, Ill.							
I 4212	Red Comb Alfalfa Meal.....	Niles..... { G.*	8.2	13.5	1.0	35.0	.....
		{ F.*	8.2	17.6	1.9	24.0	3.25
Chas. A. Krause Milling Co., Milwaukee, Wis.							
B 3452	Alfalfa Meal.....	Zeeland..... { G.*	9.0	14.0	1.0	30.0	.....
		{ F.*	9.0	13.6	1.5	30.3	2.00
Omaha Alfalfa Milling Co., Omaha, Neb.							
B 3777	Alfalfa Meal.....	South Haven.... { G.*	8.4	12.0	1.0	30.0	.....
B 4029	Alfalfa Meal.....	Saginaw..... { F.*	8.8	15.4	1.6	30.4	40.00
		Average.....	8.6	13.2	1.0	32.3	48.00
			8.6	14.3	1.3	31.4	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	(Trade protein.	(Trade fat.	(Trade fiber.	Price per ton or cwt.	Principal ingredients identified.
CALF MEAL.								
American Milling Co., Peoria, Ill.								
B 4385	Sucrose Calf Meal	{ G.* F.*	11.1	13.9	4.8	3.0	\$6.00	Linsed meal, malt flour, lone meal, wheat middlings, blood flour, soluble starch, dried buttermilk, corn meal.
B 4092	Farmer Brand Calf Meal	{ G.* F.*	8.8	20.9	3.0	4.0	5.00	Cottonseed meal, linsed meal, blood meal, cereal food by-products.
B 4165 B 4391	Bartlett's Calf Meal Bartlett's Calf Meal	{ G.* F.*	7.8 8.4	21.9 21.6	2.4 3.0	3.9 4.1	5.40 4.20	Cottonseed meal, linsed meal, dried milk, cooked by-products of corn, barley, wheat.
	Average		8.1	21.8	2.7	3.5		Same as B 4165 without dried milk.
Blatchford Calf Meal Factory, Waukegan, Ill.								
B 3590	Blatchford's Calf Meal	{ G.* F.*	10.3	25.9	4.0	6.3	5.50	Cottonseed meal, blood flour, wheat flour, locust bean meal, unpressed flaxseed, malt sprout, barley meal, ground beans and peas, rice powder, linsed meal, dried milk, coconut meal, cocoa shell meal, fenugreek, anise, salt.
B 3551 B 3602 B 3609 B 4313	Blatchford's Calf Meal Blatchford's Calf Meal Blatchford's Calf Meal Blatchford's Calf Meal		10.2 10.1 12.4 10.3	29.1 28.2 26.6 26.7	5.2 4.9 6.9 6.1	6.9 7.4 7.0 7.1	94.00 6.50 6.00 5.10	Same as B 3590. Same as B 3590. Same as B 3590. Same as B 3590.
	Average		10.7	27.4	6.0	6.9		
Dodge Hooker Mills, Wausau, Wis.								
B 4398	Wisconsin Calf Meal	{ G.* F.*	10.0	24.9	5.3	5.3	5.00	Cottonseed meal, linsed meal, pea meal, wheat flour, blood flour, flaxseed meal, corn germ meal.
Hales & Edwards Co., Chicago, Ill.								
B 3678 B 4879	Red Horn Calf Meal Red Horn Calf Meal	{ G.* F.*	11.1 10.6	16.6 18.2	4.0 4.6	2.7 3.5	5.25 5.25	Alfalfa meal, oat flour, corn flour, barley flour, red dog flour, dried buttermilk, oat meal, dextrose, salt.
	Average		10.9	17.4	4.3	3.1		Same as B 3678 with calcium carbonate.
B 4594	International Sugar Feed Co., Minneapolis, Minn. International Calf Meal	{ G.* F.*	10.1	26.7	6.5	10.0		Linsed meal, locust bean meal, red dog flour, ground screenings, fenugreek.

	Chas. A. Krause Milling Co., Milwaukee, Wis.	Lamprey Products Co., St. Paul, Minn.	J. C. Martin Co., Mineral Point, Wis.	National Food Co., Fond Du Lac, Wis.	Purina Mills Co., St. Louis, Mo.	Quaker Oats Co., Chicago, Ill.	Ryde & Company, Chicago, Ill.
B 3880 B 4975	Krause Calf Meal..... Krause Calf Meal.....	Average.....	Martin's Calf Meal..... Martin's Calf Meal.....	No-Milk Calf Feed..... No-Milk Calf Feed.....	Purina Calf Chow..... Purina Calf Chow..... Purina Calf Chow.....	Schumacher Calf Meal..... Schumacher Calf Meal..... Schumacher Calf Meal.....	Ryde's Cream Calf Meal.....
	{ G* F* M.L. Chems.	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....
	9.8 10.4 10.1	30.0 31.9 30.0	26.0 25.6 24.7	17.2 21.9 19.6	33.0 32.5 32.8	18.0 18.1 18.3	25.0 25.7 25.4
	5.0 4.5 3.7	5.0 4.5 3.7	5.9 6.3 6.3	6.0 5.7 5.7	3.3 3.2 3.5	6.8 6.8 7.5	6.6 6.6 6.6
	5.20 5.50 Same as B 3880 without bran.	4.9 4.9 4.9	6.0 6.0 6.0	5.8 5.8 5.8	5.9 5.9 5.9	3.6 3.6 3.6	2.4 2.4 2.4
B 3748	Cottonseed meal, linseed meal, gluten meal, locust bean meal, blood meal, oat meal, corn meal, rye middlings, femureck, charcoal, salt.	Royal Oak.....	Ewart.....	Bark River.....	Harbor Beach.....	Hovell.....	Albion.....
		{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....
	15.00	9.2	8.6	9.9	11.2	9.2	11.3
	10.00	25.0	25.6	21.9	33.0	18.0	25.0
	5.5	4.9	5.9	6.0	3.3	6.8	6.6
	5.50	5.50	6.0	5.7	3.2	6.8	6.6
	Same as B 4120 with cottonseed meal.	6.4	6.3	5.7	3.5	7.5	6.6
B 3974	Cottonseed meal, linseed meal, cocanut meal, blood meal (trace), wheat flour, germ middlings, corn meal, oat meal, peanut oil meal, femureck, charcoal (trace), salt.	Royal Oak.....	Ewart.....	Bark River.....	Harbor Beach.....	Hovell.....	Albion.....
		{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....
	5.50	9.2	8.6	9.9	11.2	9.2	11.3
	10.0	25.0	25.6	21.9	33.0	18.0	25.0
	5.5	4.9	5.9	6.0	3.3	6.8	6.6
	5.50	5.50	6.0	5.7	3.2	6.8	6.6
	Same as B 4120 without blood meal.	6.4	6.3	5.7	3.5	7.5	6.6
B 4582 B 4548	Linseed meal, middlings, femureck, anise, charcoal, salt.	Royal Oak.....	Ewart.....	Bark River.....	Harbor Beach.....	Hovell.....	Albion.....
		{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....
	5.75	9.2	8.6	9.9	11.2	9.2	11.3
	6.00	25.0	25.6	21.9	33.0	18.0	25.0
	Same as B 4532.	5.1	5.9	6.0	3.3	6.8	6.6
	6.00	5.7	6.3	5.7	3.5	7.5	6.6
B 4123 B 3632 B 4067	Linseed meal, hominy feed, blood meal, wheat flour.	Royal Oak.....	Deckerville.....	Bark River.....	Harbor Beach.....	Hovell.....	Albion.....
		{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....
	5.75	9.2	8.6	9.9	11.2	9.2	11.3
	5.00	25.0	25.6	21.9	33.0	18.0	25.0
	3.40	4.9	5.9	6.0	3.3	6.8	6.6
	Same as B 4123.	5.1	6.3	5.7	3.5	7.5	6.6
B 3750 B 3848 B 4075	Wheat meal, oat meal, ground flaxseed, milk albumen, linseed meal, bicarbonate of soda.	Royal Oak.....	Deckerville.....	Bark River.....	Harbor Beach.....	Hovell.....	Albion.....
		{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....
	5.25 5.00 Same as B 3750 with blood meal.	4.9 4.9 4.9	6.0 6.0 6.0	5.8 5.8 5.8	5.9 5.9 5.9	3.6 3.6 3.6	2.4 2.4 2.4
	5.00 Same as B 3848.	5.00	6.0	5.8	5.9	3.6	2.4
B 3903	Cottonseed meal, hominy feed, blood flour, wheat flour, ground flaxseed, locust bean meal, beans and peas, cocoa shell meal, femureck, anise, salt.	Ryde's Cream Calf Meal.....	Ryde's Cream Calf Meal.....	Ryde's Cream Calf Meal.....	Ryde's Cream Calf Meal.....	Ryde's Cream Calf Meal.....	Ryde's Cream Calf Meal.....
		{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....	{ G* F* Average.....
	6.50	25.0	25.6	25.4	25.4	25.4	25.4
	6.50	4.6	4.6	4.6	4.6	4.6	4.6
	4.00	7.4	7.4	7.4	7.4	7.4	7.4
	Same as B 3603.	6.9	6.9	6.9	6.9	6.9	6.9
	Same as B 3903.	5.50	5.50	5.50	5.50	5.50	5.50
	Same as B 3903.	5.00	5.00	5.00	5.00	5.00	5.00

*Abbreviations for Guaranteed and Found.

ANALYSIS OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein. %	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Ryde & Co., Chicago, Ill.—Con.								
B 4650	Ryde's Cream Calf Meal	Saginaw	9.4	25.0	6.1	7.8	\$5.00	Same as B 3603.
B 4663	Ryde's Cream Calf Meal	Bay City	9.1	24.5	5.7	7.1	5.00	Same as B 3603.
B 4853	Ryde's Cream Calf Meal	Elberta	10.3	23.3	5.9	9.6	5.50	Same as B 3603.
		Average	10.3	24.7	5.6	7.5		
Security Food Co., Minneapolis, Minn.								
B 2922	Security Food Compound	Midleton	(G.* 9.9	9.8 15.0	4.5 5.0	6.0 6.7	20.00	Locust bean meal, dried milk, wheat flour, wheat middlings, corn starch, oxide of iron, sugar, capsicum, fenugreek, anise.
B 4170	Security Food Compound	Litchfield	(F.* 10.5	14.8	4.4	6.1	20.00	Wheat flour, wheat middlings, corn starch, sugar, ginger, iron oxide, fenugreek, anise.
		Average	10.2	14.9	4.7	6.4		
E. L. Wellman, Grand Rapids, Mich.								
B 2977	Wellman's Qualified Calf Meal	Conklin	(G.* 9.2	18.0 16.8	8.0 6.0	4.0 2.4	4.50	Linseed meal, ground flaxseed, wheat meal, oat meal, corn feed meal, milk albumen, bicarbonate of soda.
HOG FEEDS.								
Amendt Milling Co., Monroe, Mich.								
B 4436	Amco Hog Feed	Monroe	(G.* 9.8	15.0 16.9	4.5 4.2	8.0 6.0	2.90	Linseed meal, gluten feed, clipped oat by-product, tankage, corn feed meal, barley, dried milk.
B 4730	Amco Hog Feed	Trenton	(F.* 8.5	18.7	4.5	6.1	3.50	Same as B 4436 with wheat middlings.
		Average	9.2	17.8	4.4	6.1		
American Milling Co., Peoria, Ill.								
B 2347	Sucrene Hog Meal	Detroit	(G.* 11.3	18.0 21.8	4.0 4.1	14.0 8.5	62.00	Linseed meal, gluten feed, distillers' grains, blood flour, alfalfa meal, corn, corn feed meal, palm kernel meal, molasses, salt.
B 4356	Sucrene Hog Meal	Negaunee	(F.* 11.3	19.0	5.0	7.4	4.00	Linseed meal, alfalfa meal, blood flour, palm kernel meal, corn germ meal, corn feed meal, peanut oil meal, molasses, salt.
		Average	11.3	20.4	4.6	8.0		
J. E. Bartlett Co., Jackson, Mich.								
B 4903	Daisy Hog Feed	Jackson	(G.* 9.6	18.0 16.2	4.0 2.7	12.0 4.9	2.50	Cottonseed meal, linseed meal, wheat (trace), tankage, corn screenings, rye (trace), cooked by-products of corn and barley.
Blatchford Calf Meal Factory, Waukegan, Ill.								
B 4199	Blatchford's Pig Meal	Adrian	(G.* 10.0	18.0 22.0	5.0 5.8	7.0 6.4	5.20	Cottonseed meal, linseed meal, malt sprouts meal, beans, peas, flaxseed, rice polish, blood meal, wheat flour, locust bean meal, oat meal, corn meal, barley sprouts meal, anise, salt.
B 4320	Blatchford's Pig Meal	Cheboygan	10.0	19.5	4.8	6.9	4.75	Same as B 4199 without malt sprouts meal, beans, and peas.
B 4837	Blatchford's Pig Meal	Traverse City	9.8	23.5	5.9	6.4	96.00	Same as B 4199.
		Average	9.9	21.7	5.5	6.6		

The C. E. DePuy Co., Pontiac, Mich.		$\left\{ \begin{array}{l} G^* \\ F^* \end{array} \right\}$		$\left\{ \begin{array}{l} 13.5 \\ 13.8 \end{array} \right\}$		$\left\{ \begin{array}{l} 7.7 \\ 7.0 \end{array} \right\}$		Linsced meal, wheat middlings, oats, corn, barley.	
B 4751	Hog Feed.....			12.1	13.8	3.7	6.3		
Albert Dickinson Co., Chicago, Ill.									
B 4388	Queen Hog Fatting Ration.....			10.5	13.5	5.0	12.5		Linsced meal, pea meal, alfalfa meal, wheat middlings, corn feed meal, ground corn bran, barley feed, tankage, ground screenings
B 4502	Queen Hog Fatting Ration.....			10.7	17.2	4.9	7.0	3.00	Same as B 4388, with salt.
	Average.....			10.6	17.1	5.0	7.4		
B 3350	Rival Hog Feed.....			11.2	12.5	3.0	12.5		Linsced meal, corn feed meal, kafir, ground corn bran, alfalfa meal, ground wheat and barley screenings.
B 3500	Rival Hog Feed.....			11.4	14.8	4.4	8.4	5.00	Linsced meal, alfalfa meal, corn feed meal, ground corn bran, ground screenings from wheat, oats, barley, and kafir, salt.
B 3508	Rival Hog Feed.....			10.2	13.1	3.8	11.4	60.00	Same as B 3500.
B 3693	Rival Hog Feed.....			9.7	13.0	2.8	10.0	52.00	Same as B 3500 without salt.
B 4290	Rival Hog Feed.....			10.6	11.2	3.7	9.0	60.00	Same as B 3500.
B 4507	Rival Hog Feed.....			9.8	16.4	4.4	9.9	3.00	Same as B 3500.
	Average.....			10.5	11.4	4.1	9.7		
Dodge Hooker Mills, Wausau, Wis.									
B 4521	Wisconsin Pig Ration.....			11.0	15.0	4.0	10.0	3.40	Linsced meal, hominy meal, wheat middlings, rye middlings.
†Caughy Jossman Co., Detroit, Mich.									
B 3362	Common Sense Hog Feed.....			10.0	17.0	9.2	14.2		Cottonseed meal, linsced meal, wheat middlings, pea meal, peanut bran, corn products, oat product.
B 4004	Common Sense Hog Feed.....			10.7	14.9	6.1	10.2	52.00	Same as B 3362.
	Average.....			10.7	13.3	6.3	9.8		
Hales & Edwards Co., Chicago, Ill.									
B 3470	Pioneer Hog Feed with dried buttermilk.....			11.6	12.0	3.0	12.0		Linsced meal, wheat middlings, corn feed meal, ground wheat, barley and kafir screenings, dried buttermilk.
B 3476	Pioneer Hog Feed with dried buttermilk.....			11.5	14.5	5.3	6.1		Same as B 3470.
B 3488	Pioneer Hog Feed with dried buttermilk.....			11.7	13.5	3.8	6.1	63.50	Same as B 3470.
B 3502	Pioneer Hog Feed with dried buttermilk.....			11.6	14.4	3.8	6.8	74.00	Same as B 3470.
B 3507	Pioneer Hog Feed with dried buttermilk.....			11.4	12.8	4.2	5.6	3.50	Same as B 3470.
B 3508	Pioneer Hog Feed with dried buttermilk.....			11.4	12.6	4.1	5.4	68.00	Same as B 3470 with oat hulls.
B 3509	Pioneer Hog Feed with dried buttermilk.....			10.8	13.6	4.3	7.5	75.00	Same as B 3470.
B 3589	Pioneer Hog Feed with dried buttermilk.....			12.5	13.1	4.3	4.8		Same as B 3470.
B 4317	Pioneer Hog Feed with dried buttermilk.....			10.6	12.6	4.6	6.5	69.00	Same as B 3470.
B 4580	Pioneer Hog Feed with dried buttermilk.....			10.6	12.8	4.5	4.8	3.40	Same as B 3470.
	Average.....			11.3	13.3	4.4	5.8		

^a Abbreviations for Guaranteed and Found.

The brand listed below was licensed by the Panabella Co., whose business has been taken over by this company.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
International Sugar Feed Co., Minneapolis, Minn.								
B 4391	International Climax Hog Feed.....	{ G.* F.*	15.0 10.9	5.0 14.8	5.0 5.4	10.0 8.9	83.10	Linseed meal, coconut meal, alfalfa meal, wheat middlings ground screenings, molasses, salt.
B 3193	International Hog Feed.....	{ G.* F.*	22.5 21.2	5.0 5.8	5.0 5.8	12.0 13.8	.....	Linseed meal, tankage, ground middlings, molasses, charcoal, salt.
B 3392	International Hog Feed.....	{ G.* F.*	9.6 20.5	5.3 20.5	5.3 5.3	14.1 14.1	60.00	Same as B 3193. *
	Average.....		10.0	20.9	5.6	14.0	.....
Interstate Feed Association, Toledo, Ohio.								
B 4171	Superior Hog Feed.....	{ G.* F.*	15.0 10.4	16.1 16.1	3.5 2.9	18.5 18.2	2.83	Cottonseed hulls, linseed meal, tankage, corn, ground screenings, molasses, charcoal, salt.
B 3361	Ithaca Roller Mills, Ithaca, Mich. Renown Hog Feed.....	{ G.* F.*	11.1 10.2	11.1 11.1	3.0 2.6	3.5 4.0	.....	Wheat, wheat bran and middlings, oat meal mill by-products, corn feed meal, barley.
Chas. A. Krause Milling Co., Milwaukee, Wis.								
B 3433	Badger Hog Feed.....	{ G.* F.*	15.0 10.1	17.3 16.3	4.7 4.8	7.5 4.8	3.25	Linseed meal, gluten feed, hominy feed, tankage, corn feed meal, corn germ meal, corn red dog flour, salt.
B 3772	Badger Hog Feed.....	{ G.* F.*	10.1 10.1	16.6 16.6	4.4 4.4	5.3 5.3	65.00	Same as B 3433 with wheat middlings.
B 3387	Badger Hog Feed.....	{ G.* F.*	9.5 10.3	18.6 16.4	4.2 5.5	5.2 4.0	65.00	Same as B 3433 without gluten feed.
B 3958	Badger Hog Feed.....	{ G.* F.*	10.3 10.3	16.4 16.4	5.5 4.8	4.2 4.5	68.00	Same as B 3433.
B 4304	Badger Hog Feed.....	{ G.* F.*	9.0 9.0	13.8 17.4	4.8 5.4	4.5 6.3	64.00	Same as B 3772.
B 4352	Badger Hog Feed.....	{ G.* F.*	10.0 10.0	16.7 16.7	4.9 4.9	5.1 5.1	3.60	Same as B 3772.
	Average.....		10.0	16.7	4.9	5.1	.....
B 3487	Krause Hog Feed.....	{ G.* F.*	15.0 11.3	16.9 16.9	4.0 4.1	9.0 9.5	70.00	Hominy feed, alfalfa meal, wheat bran and middlings, rye middlings, corn germ meal, corn feed meal, peanut oil meal, tankage, salt.
B 4151	Krause Hog Feed.....	{ G.* F.*	10.8 10.2	14.0 13.9	5.0 5.0	6.1 6.2	2.80	Same as B 3487 without bran and with velvet bean feed.
B 4097	Krause Hog Feed.....	{ G.* F.*	10.2 10.2	16.7 16.7	5.0 5.0	7.5 7.0	70.00	Same as B 3487 with velvet bean feed.
B 4190	Krause Hog Feed.....	{ G.* F.*	9.7 9.7	17.9 17.9	4.4 4.4	10.7 10.7	3.00	Same as B 4097.
B 4559	Krause Hog Feed.....	{ G.* F.*	10.4 10.4	16.9 16.9	4.9 4.9	8.3 8.3	62.00	Same as B 4097.
	Average.....		10.4	16.9	4.9	8.3	.....
Park & Pollard Co., Chicago Ill.								
B 4716	Go-twit Hog Ration.....	{ G.* F.*	15.0 8.0	15.2 8.0	6.0 6.9	13.0 9.5	3.50	Linseed meal, hominy feed, coconut meal, fish, bone meal, blood meal, alfalfa meal, wheat middlings, peanut oil feed, rice bran, oat meal mill by-products, corn meal, corn germ meal, salt, calcium carbonate.

	Purina Mills Co., St. Louis, Mo.		(1918) Grand Rapids Croswell	{ G.* F.*}	10.8 15.6 10.1	17.0 15.6 15.3	3.2 3.3 3.5	9.0 10.0 11.0	64.00 3.50	Alfalfa meal, corn feed meal, tankage, peat, molasses. Alfalfa meal, ground wheat, tankage, corn, molasses, charcoal, salt.
B 3447 B 4139	Purina Pig Chow Purina Pig Chow	Average.....	10.5	15.5	3.4	10.5				
B 4486	Purina Pig Chow	(1919) Lainburg { G.* F.*}	10.9	15.4	3.4	11.3	3.25			Alfalfa meal, tankage, corn feed meal, molasses, salt, peat.
B 4903	Ryde & Co., Chicago, Ill. Ryde's Pig Meal	{ G.* F.*}	11.0	20.2	6.7	6.0 6.1	6.0 6.1	5.00		Cottonseed meal, locust bean meal, flaxseed, beans, cocoashell meal, meat scraps, blood meal, wheat middlings, oat meal, corn meal, feedcrack, auise, salt.
B 3198 B 3478 B 3890 B 3919	Watson Higgins Milling Co., Grand Rapids, Mich. Hog Feed Hog Feed Hog Feed Hog Feed	{ G.* F.*}	12.4 11.9 9.9 11.1	7.1 9.1 9.6 9.6	1.3 3.4 2.0 3.3	6.1 3.5 4.3 7.9	6.1 3.5 4.3 7.9	42.00 53.00		Wheat, oats, rye, kafir, barley, corn feed meal. Oats, barley, buckwheat, corn feed meal, wheat screenings. Same as B 3478 without barley. ^{note 1-4} Wheat, oats, buckwheat, rye, corn feed meal.
B 3170 B 3765	E. L. Wellman, Grand Rapids, Mich. Qualified Hog Feed Qualified Hog Feed	{ G.* F.*}	9.1 10.0	10.4 15.1	3.8 3.6	10.0 7.4	10.0 7.4	10.0 55.00		Cottonseed meal, linseed meal, hominy feed, yellow hominy feed, ground corn, ground barley, wheat middlings, oat meal mill by- product, ground puffed rice and wheat, calcium phosphate, salt. Linseed meal, gluten feed, yellow hominy feed, oat meal mill by- product, rye middlings, barley, calcium phosphate, salt.
B 3771 B 3911	Qualified Hog Feed Qualified Hog Feed		9.3 9.3	10.1 10.1	4.1 3.8	9.6 10.1	9.6 10.1	56.00 60.00		Same as B 3170. Same as B 3170.
B 4494	Amendt Milling Co., Monroe, Mich. Amco Dairy Feed	{ G.* F.*}	9.1	21.7	5.7	13.0 12.5	13.0 12.5	3.00		Cottonseed meal, linseed meal, gluten feed, brewers grains, wheat bran and middlings, oat feed, barley.
B 3401 B 3767 B 4176 B 4911	Armour Grain Co., Chicago, Ill. Armour Dairy Feed Armour Dairy Feed Armour Dairy Feed Armour Dairy Feed	{ G.* F.*}	8.9 8.5 8.2	22.5 22.1 23.3	5.0 4.7 5.3	15.9 14.5 13.0	15.9 14.5 13.0	62.00 60.00		Cottonseed meal, linseed meal, gluten feed, hominy feed, wheat bran, oat meal mill by-product, corn oil meal, coconut oil meal, salt. Same as B 3401. Same as B 3401. Same as B 3401.

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUTTS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
B 429S	Armour Grain Co., Chicago, Ill.—Con.	Paw Paw.....	{ G.* F.*	12.0 13.3	4.0 4.4	12.0 11.7	\$5.00	Cottonseed meal, hominy feed, wheat middlings, oat meal mill by-product, ground corn, ground barley, corn oil meal, salt.
B 3959	Badenoch's Stock Feed.....	Edmore.....	{ G.* F.*	8.0 8.0	5.0 2.6	12.0 9.8	60.00	Hominy feed, oat meal mill by-product, corn feed meal, salt.
B 4508 B 4545	Cereal Mills Co., Wausau, Wis. Cenoco Ready Ration Dairy Feed..... Cenoco Ready Ration Dairy Feed.....	Vulcan..... Daggett.....	{ G.* F.*	18.0 13.1 18.9 19.8	5.0 5.2 5.6 5.6	11.0 8.6 8.4	2.75 3.50	Cottonseed meal, linseed meal, hominy meal, brewers' grains, wheat bran and middlings, salt. Same as B 4508 with gluten feed and malt sprouts.
B 3179 B 3802 B 3871 B 3966 B 4551	Chapin & Company, Chicago, Ill. Triangle Dairy Feed..... Triangle Dairy Feed..... Triangle Dairy Feed..... Triangle Dairy Feed..... Triangle Dairy Feed.....	Average..... Hudsonville..... Zeeland..... Allegan..... Mt. Pleasant..... Menominee.....	11.3 { G.* F.*	19.4 21.0 20.3 25.6 22.8 21.9 22.8	5.4 4.0 5.6 5.7 5.5 4.9 5.4	8.5 12.0 7.4 11.0 11.2 11.5 12.2	..... 60.00 62.00 59.00 61.00 62.00	Cottonseed meal, linseed meal, gluten feed, hominy feed, copra meal, oat meal mill by-product, corn germ meal, salt. Same as B 3179. Same as B 3179. Same as B 3179. Same as B 3179. Same as B 3179.
B 3180 B 3688 B 3801 B 3856 B 3873 B 3968 B 4362	Unicorn Dairy Ration..... Unicorn Dairy Ration..... Unicorn Dairy Ration..... Unicorn Dairy Ration..... Unicorn Dairy Ration..... Unicorn Dairy Ration..... Unicorn Dairy Ration.....	Average..... Hudsonville..... Lansing..... Zeeland..... Moline..... Allegan..... Lake Odessa..... Ishtyming.....	8.3 { G.* F.*	22.3 26.0 26.5 26.7 26.7 26.7 26.7 26.7	5.4 5.5 6.7 7.0 6.3 5.7 5.7 5.9	11.0 8.6 9.0 9.6 10.4 9.5 9.4 9.5	..... 68.00 3.50 67.00 65.00 63.00 68.00 72.00	Cottonseed meal, linseed meal, gluten feed, hominy meal, brewers' grains, corn distillers' grains, copra meal, corn starch by-products, corn bran, wheat bran, barley feed, salt. Same as B 3180. Same as B 3180. Same as B 3180. Same as B 3180. Same as B 3180. Same as B 3180. Same as B 3180.
B 3439 B 3863 B 3879 B 4458 B 4743 B 4857 B 4880	Albert Dickinson Co., Chicago, Ill. Dickinson Dairy Feed..... Dickinson Dairy Feed..... Dickinson Dairy Feed..... Dickinson Dairy Feed..... Dickinson Dairy Feed..... Dickinson Dairy Feed.....	Average..... Jamestown..... Holland..... Muskegon..... Grand Lodge..... Hillsdale..... Manistee..... Ludington.....	8.9 { G.* F.*	26.0 24.0 23.9 23.6 24.3 21.9 24.3 24.3	6.2 5.5 5.0 5.7 6.5 5.2 5.1 5.1	9.5 11.0 10.1 9.1 9.6 8.7 9.8	..... 60.00 66.00 61.00 66.00 3.25 3.25 3.50	Cottonseed meal, linseed meal, gluten feed, brewers' grains, whe. bran and middlings, salt. Same as B 3439 with hominy feed. Same as B 3803. Same as B 3803. Same as B 3803. Same as B 3803. Same as B 3803. Same as B 3803.

		Belleville.....	9.6	24.8	5.1	9.6	3.25	
B 4806	Dickinson Dairy Feed.....	Average.....	9.8	24.2	5.4	9.5	.....	Same as B 3503.
B 4328	Queen Dairy Feed.....	{ G.*	.....	20.0	4.0	10.0	.....	Cottontseed meal, linseed meal, gluten feed, malt sprouts, wheat
B 4514	Queen Dairy Feed.....	{ F.*	9.4	21.5	5.5	10.1	72.00	bran and middlings, corn feed meal, salt.
		Escondido.....	10.6	20.2	4.9	10.4	66.00	Same as B 4328 without gluten feed.
		Average.....	10.0	20.9	5.2	10.3	.....
B 3868	White Cross Stock Feed.....	{ G.*	.....	10.0	3.5	10.0	.....	Cottontseed meal, wheat middlings, ground oats, ground corn,
B 4506	White Cross Stock Feed.....	{ F.*	10.8	10.5	4.1	5.9	67.00	ground barley, salt.
		Crystal Falls.....	11.1	15.4	4.4	9.4	3.25	Cottontseed meal, wheat meal, ground oats, corn feed meal, ground
		Average.....	11.0	13.0	4.3	6.2	.....	corn bran, ground barley, salt.
B 3970	Dixie Mills Co., East St. Louis, Ill. Polo Dairy Feed.....	{ G.*	.....	17.5	3.5	16.0	.....	Cottontseed meal, brewers' grains, corn feed meal, clipped oat by-
		{ F.*	8.3	16.3	6.1	17.7	53.00	product, ground flaxseed screenings.
B 4300	Dodge Hooker Mills, Wausau, Wis. Wisconsin Balanced Ration.....	{ G.*	.....	18.0	5.0	11.0	.....	Cottontseed meal, linseed meal, hominy meal, malt sprouts, wheat
B 4322	Wisconsin Balanced Ration.....	{ F.*	10.3	19.0	5.1	9.4	3.10	bran and middlings barley feed, salt.
		Escondido.....	10.4	18.5	5.0	9.4	3.50	Same as B 4399 with gluten feed and brewers grains.
		Average.....	10.4	18.8	5.1	9.4	.....
B 3361	†Caughy Jossman Co., Detroit, Mich. Common Sense Dairy Feed.....	{ G.*	.....	13.3	5.5	12.3	.....	Cottontseed meal, wheat bran, peanut bran, corn products, oat
B 4942	Common Sense Dairy Feed.....	{ F.*	10.7	13.8	5.9	12.3	52.00	products.
		Birmingham.....	10.1	13.8	6.0	11.1	3.00	Cottontseed meal, alfalfa, wheat bran and middlings, peanut meal,
								corn feed meal, oat by-products.
B 3411	Hales & Edwards Co., Chicago, Ill. Eatall Dairy Feed.....	{ G.*	.....	30.0	4.0	10.0	.....	Cottontseed meal, linseed meal, gluten feed, hominy feed, brewers'
B 3691	Eatall Dairy Feed.....	{ F.*	10.0	22.3	4.2	9.1	63.00	grains, malt sprouts, wheat bran, corn feed meal, ground oats,
		Lausaug.....	10.3	20.7	5.2	9.9	3.25	ground barley.
		Average.....	10.2	21.5	4.7	9.1	.....	Cottontseed meal, linseed meal, gluten feed, alfalfa meal, corn feed
B 3659	Pioneer Stock Feed.....	{ G.*	.....	10.0	2.5	9.0	.....	meal, ground oats, ground barley, dried buttermilk.
B 4571	Pioneer Stock Feed.....	{ F.*	11.5	12.3	3.7	5.9	3.25	Hominy feed, wheat bran and middlings, oats, oat meal mill by-
		Charlevoix.....	9.5	16.2	3.2	9.6	3.25	product, corn feed meal, barley feed.
		Average.....	10.5	14.3	3.5	7.8	.....	Gluten feed, wheat bran and middlings, oat meal mill by-products,
								corn feed meal, barley feed.
B 3459	Red Horn Dairy Feed.....	{ G.*	.....	25.0	4.0	15.0	.....	Cottontseed meal, linseed meal, gluten feed, brewers' grains, malt
B 3472	Red Horn Dairy Feed.....	{ F.*	10.4	24.6	4.4	9.2	65.00	sprouts, wheat bran, corn feed meal.
B 3533	Red Horn Dairy Feed.....		11.0	23.2	4.5	10.2	65.00	Same as B 3459.
			9.0	21.3	4.5	11.2	60.00	Same as B 3459.

*Abbreviations for Guaranteed and Found.

†The brand listed below was licensed by the Fumabella Co., whose business has been taken over by this company.

B 4812	Cream City Dairy Feed	Traverse City	8.2	19.8	4.5	15.2	3.00	Same as B 3134 without velvet bean feed.
		Average		4.5	4.5	13.6		
B 4801	Cream City Dairy Feed	(1919) Petoskey	8.6	19.0	4.5	15.0		Same as B 3405.
B 3378	Krause Dairy Feed	Petoskey	8.6	22.6	5.2	12.7	2.85	Cottonseed meal, linseed meal, gluten feed, hominy feed, distillers' grains, brewers' grains, corn germ meal, wheat bran and middlings, rye middlings, salt.
B 3358	Krause Dairy Feed	Hudsonville	8.2	24.3	5.6	10.6	60.00	Cottonseed meal, linseed meal, gluten feed, brewers' grains, malt sprouts, distillers' grains, wheat bran and middlings, rye middlings, oat shorts, corn germ meal, salt.
B 3458	Krause Dairy Feed	Zeeland	9.8	24.8	4.7	10.8	65.00	Same as B 3158 without rye middlings.
B 3486	Krause Dairy Feed	Forest Grove	9.1	24.8	5.2	10.4	62.50	Same as B 3458 without rye middlings and oat shorts, with corn.
B 3710	Krause Dairy Feed	St. Johns	8.3	23.9	6.1	12.8	66.50	Same as B 3710 with hominy feed.
B 3717	Krause Dairy Feed	Owosso	8.6	25.4	5.4	11.1	3.35	Same as B 3717 without corn and corn germ meal.
B 3330	Krause Dairy Feed	Holland	8.9	22.3	5.9	10.7	68.00	Same as B 3717 without corn and corn germ meal.
B 3997	Krause Dairy Feed	Nashville	9.3	25.1	5.9	10.6	65.00	Same as B 3486 with rye middlings.
B 4089	Krause Dairy Feed	Bad Axe	8.3	23.8	6.9	12.4	66.00	Same as B 4118.
B 4118	Krause Dairy Feed	DeKerville	9.4	23.8	6.3	11.4	3.25	Same as B 4118.
B 4204	Krause Dairy Feed	Premont	9.1	23.6	5.8	11.8	66.00	Same as B 4089.
B 4251	Krause Dairy Feed	Grand Rapids	8.9	23.5	4.6	11.8	61.00	Same as B 4089.
B 4560	Krause Dairy Feed	Spaulding	8.4	24.3	5.2	10.5	3.25	
B 4802	Krause Dairy Feed	Petoskey	8.2	26.1	5.7	10.4		
		Average	8.8	24.4	5.7	11.1		
B 3457	Krause Stock Feed	(1919) Forest Grove	10.2	10.0	4.5	12.0		Hominy feed, corn red dog flour, oat meal mill by-products, salt.
B 3489	Krause Stock Feed	Zeeland	11.4	9.2	3.6	6.8	59.00	Same as B 3457 with corn germ meal.
B 4117	Krause Stock Feed	DeKerville	10.2	9.1	4.5	9.8	2.75	Same as B 3457 without hominy feed.
		Average	10.6	9.1	4.3	9.1		
B 3352	Larowe Feed	(1919) Detroit	9.1	20.0	4.0	14.0	62.00	Cottonseed meal, linseed meal, gluten feed, dried beet pulp, corn feed meal, wheat bran and middlings, salt.
B 3466	Larowe Feed	Zeeland	10.0	20.6	4.7	10.9	62.00	Same as B 3352.
B 3806	Larowe Feed	Holland	10.1	19.6	4.0	11.6	64.00	Same as B 3352.
B 3905	Larowe Feed	Muskegon Heights	9.9	21.3	5.0	11.6	64.00	Same as B 3352 without corn feed meal.
B 4083	Larowe Feed	Owensale	8.7	21.1	4.7	11.4	3.00	Same as B 3352 without corn feed meal.
B 4891	Larowe Feed	Wayne	10.7	21.7	4.0	11.6		
		Average	9.8	20.8	4.4	11.5		
B 3411	Larowe Big Six Complete Dairy Feed	(1919) Detroit	10.7	21.0	4.0	12.0	62.00	Cottonseed meal, linseed meal, gluten feed, hominy feed, wheat bran and middlings, rye middlings, corn feed meal, salt.
B 3483	Larowe Big Six Complete Dairy Feed	Forest Grove	10.4	22.3	5.5	6.9	62.00	Same as B 3441.
B 3753	Larowe Big Six Complete Dairy Feed	Lowell	10.2	22.2	4.5	7.4	62.00	Same as B 3441.
B 3816	Larowe Big Six Complete Dairy Feed	Rehoboth	10.1	20.5	5.8	8.6	62.00	Same as B 3441.
B 4000	Larowe Big Six Complete Dairy Feed	Rehoboth	9.0	21.7	6.0	8.5	65.00	Same as B 3441.
B 4122	Larowe Big Six Complete Dairy Feed	Bad Axe	9.0	21.4	5.9	8.7	3.35	Same as B 3441.
		Harbor Beach	9.8	21.6	6.0	8.1		
		Average	10.0	21.7	5.6	8.1		

*Abbreviations for Guaranteed and Foul.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
B 4113 B 4119	McMorran Milling Co., Port Huron, Mich. Protein Feed Protein Feed	{ G.* P.* Sundusky. Decker ville. Average.	10.3 9.6 10.0	20.0 16.3 17.6	3.0 3.2 4.0	1.2 18.9 15.3	\$2.85 2.90	Cottonseed meal, linseed meal, gluten feed, hominy feed, alfalfa meal, salt. Cottonseed meal, linseed meal, gluten feed, wheat bran, pea bran, oat feed, salt.
B 3928 B 3930 B 3976 B 4032 B 4112	Omaha Alfalfa Milling Co., Omaha, Neb. Beauty Dairy Feed Beauty Dairy Feed Beauty Dairy Feed Beauty Dairy Feed Beauty Dairy Feed	{ G.* P.* Holland. Muskegon. Wayland. Saginaw. Mariette. Average.	9.2 9.8 9.7 9.0 9.8	20.9 20.4 23.7 16.6 16.6	3.0 4.0 3.7 3.1 4.2	20.0 15.9 13.9 15.2 13.7	56.40 56.40 60.00 3.15	Cottonseed meal, linseed meal, alfalfa meal, wheat bran, corn meal. Same as B 3928. Same as B 3928. Same as B 3928. Same as B 3928.
B 3413	Park & Pollard Co., Chicago, Ill. Steven's 44 Dairy Ration	{ G.* P.* Grand Rapids. Average.	9.5 9.2	21.0 21.8	4.0 5.5	15.1 14.0 10.8	61.00	Cottonseed meal, linseed meal, gluten feed, hominy feed, brewers' grains, distillers' grains, malt sprouts, wheat bran and middlings, corn germ meal, corn feed meal, buckwheat middlings, ground barley, cocoanut oil meal, pea meal, salt.
B 3423 B 3670 B 3832 B 3870 B 3893 B 4203 B 4555	Steven's 44 Dairy Ration Steven's 44 Dairy Ration Steven's 44 Dairy Ration Steven's 44 Dairy Ration Steven's 44 Dairy Ration Steven's 44 Dairy Ration Steven's 44 Dairy Ration	{ G.* P.* Grand Rapids. Lansing. Holland. Alegan. Eaton Rapids. Fremont. Traverse City. Average.	8.7 8.3 8.3 8.3 8.8 9.6 9.6	24.6 25.2 23.7 24.1 26.5 23.8 26.3	5.1 5.5 6.1 5.7 5.4 5.6 5.6	13.4 9.6 9.6 11.4 11.7 10.5 10.1	3.50 65.00 68.00 61.00 63.00 3.40	Same as B 3413. Same as B 3413. Same as B 3413. Same as B 3413. Same as B 3413. Same as B 3413.
B 4996 B 3925 B 4146	Purina Mills, St. Louis, Mo. Lucky Strike Stock Feed Star Stock Feed Star Stock Feed	{ G.* P.* Almont. Grand Rapids. Brown City. Average.	9.0 8.8 11.0 9.2 8.9	24.9 11.0 11.4 11.8 12.8	5.7 3.0 4.0 3.8 4.8	10.9 15.0 15.8 9.0 13.5	2.30 58.00 3.00	Cottonseed meal, hominy feed, oat meal mill by-products, corn meal, cottonseed hull bran, salt. Cottonseed meal, hominy feed, oat meal middlings, oat meal mill by-products, corn feed meal, salt. Same as B 3925.
B 3745 B 3774	Quaker Oats Company, Chicago, Ill. Big Q Dairy Ration Big Q Dairy Ration	{ G.* P.* Morrice. outh Haven. (1918)	9.1 9.6 9.6	12.3 22.0 18.9	4.3 4.9 5.0	13.2 10.5 11.6	60.00	Cottonseed meal, linseed meal, gluten feed, hominy feed, distillers' grains, wheat bran and middlings, oat meal, mill by-products, Same as B 3745 with corn and molasses.

B 3901	Big Q Dairy Ration.....	Grand Rapids.....	9.3	20.6	4.8	11.1	66.00	Same as B 3745.
B 4012	Big Q Dairy Ration.....	Saginaw.....	8.9	30.6	4.7	10.0	65.00	Same as B 3745.
B 4113	Big Q Dairy Ration.....	Manitou.....	9.0	22.6	5.8	11.4	3.25	Same as B 3745.
B 4950	Big Q Dairy Ration.....	Lapeer.....	8.3	22.6	5.1	11.6	3.25	Same as B 3745.
	Average.....		9.1	21.2	5.1	11.2	.....
	(1919) {G*}							
B 4081	Big Q Dairy Ration.....	Caro.....	8.4	21.0	5.0	10.5	.....	Same as B 3745.
B 4113	Big Q Dairy Ration.....	Ann Arbor.....	9.4	23.0	5.6	10.3	60.50	Same as B 3745.
B 4852	Big Q Dairy Ration.....	Traverse City.....	9.5	21.8	5.3	12.5	3.25	Same as B 3745.
	Average.....		9.1	21.9	5.4	11.3	.....
	{G*}							
B 3743	Schnumacher Feed.....	Mason.....	10.0	11.1	3.2	10.0	.....	Cottonseed meal, hominy feed, wheat middlings, oat meal mill by-products, corn, barley, ground puffed wheat and rice, calcium phosphate, salt.
			9.0	11.1	4.1	12.2	53.00	Same as B 3745.
B 4029	Schnumacher Feed.....	Coldwater.....	8.7	10.8	4.2	11.3	50.00	Same as B 3743.
B 4073	Schnumacher Feed.....	Saginaw.....	8.8	10.2	3.6	10.1	55.00	Same as B 3743 with bran, without calcium phosphate.
B 4079	Schnumacher Feed.....	Caro.....	9.8	10.4	3.4	9.5	60.00	Same as B 3743.
B 4201	Schnumacher Feed.....	Midville.....	8.5	11.9	4.8	11.2	60.00	Same as B 3743 without calcium phosphate.
B 4240	Schnumacher Feed.....	Cadillac.....	9.7	10.7	4.7	10.7	60.00	Same as B 3743.
B 4427	Schnumacher Feed.....	Moreno.....	9.4	11.3	3.7	10.7	60.00	Same as B 3743.
B 4821	Schnumacher Feed.....	Manitou.....	9.5	10.2	3.8	11.0	2.80	Same as B 3743.
B 4850	Schnumacher Feed.....	Traverse City.....	9.0	11.0	4.2	11.0	2.75	Same as B 3743.
	Average.....		9.2	10.8	4.1	10.9	.....
	{G*}							
B 4992	Sterling Feed.....	Jackson.....	10.0	11.3	3.2	11.0	2.75	Cottonseed meal, linseed meal, hominy feed, wheat middlings, oat meal mill by-products, ground puffed wheat and rice, barley screenings, calcium phosphate and salt.
			11.2	11.3	3.4	8.5	.....
B 4656	Vitality Stock Feed.....	Grand Rapids.....	12.4	8.3	3.0	12.0	2.85	Wheat bran, oat hulls, ground oats and barley, corn feed meal, salt.
			12.4	8.3	2.6	8.1	.....
	{G*}							
B 4334	Pickford Dairy Ration.....	Sault Ste. Marie.....	11.7	14.6	3.6	5.9	.....	Wheat bran and middlings, corn bran, barley feed, ground flax, ground mixed grain.
B 4505	Pickford Dairy Ration.....	Pickford.....	11.0	13.4	3.9	7.0	70.00	Same as B 4334 with corn meal and screenings.
			11.4	14.0	4.1	7.3	2.85	
	Average.....		11.4	14.0	4.1	7.3	.....
	{G*}							
B 4504	Pickford Star Feed.....	Pickford.....	11.6	14.5	2.6	3.3	2.95	Ground peas, ground wheat, wheat middlings, ground oats, corn meal, ground barley, grain screenings.
			11.6	14.5	2.1	3.6	.....
	{G*}							
B 4550	All Stock Feed.....	Stevenson.....	10.3	13.5	4.0	13.0	.....	Cottonseed meal, linseed meal, hominy feed, wheat bran, oat meal mill by-products, salt.
B 3612	Wisconsin Vitex Dairy Feed.....	Marshall.....	24.0	6.0	3.8	12.3	60.00	Cottonseed meal, linseed meal, brewers' grains, distillers' grains, malt sprouts, gluten feed, hominy feed, wheat bran, salt.
B 3987	Wisconsin Vitex Dairy Feed.....	Lake Odessa.....	9.1	25.3	5.5	12.5	60.00	Same as B 3612 with corn oil meal.
			9.5	25.9	6.8	11.4	66.00	

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Smith, Parry & Co., Milwaukee, Wis.—Con.								
B 4088	Wisconsin Vitex Dairy Feed	Bad Axe	9.0	24.7	6.1	11.8	\$66.00	Same as B 3987.
B 4089	Wisconsin Vitex Dairy Feed	Cass City	9.8	24.7	6.1	11.9	65.00	Same as B 3987.
B 4109	Wisconsin Vitex Dairy Feed	Litchfield	9.0	25.1	6.2	12.6	66.50	Same as B 3987.
B 4373	Wisconsin Vitex Dairy Feed	Houghton	9.3	24.8	7.2	10.7	3.50	Same as B 3987.
B 4528	Wisconsin Vitex Dairy Feed	Bark River	9.3	23.8	6.4	12.7	4.25	Same as B 3987.
Ubiko Milling Co., Cincinnati, Ohio.								
Average			9.3	24.6	6.3	11.9	.....
Coopersville,			$\left\{ \begin{array}{l} G^* \\ F^* \end{array} \right.$	24.0	5.0	10.0	.....	Cottonseed meal, linseed meal, gluten feed, hominy feed, distillers' grains, brewers' grains, wheat bran and middlings, corn germ meal, malt sprouts, salt.
B 3184	Union Grains Ubiko Biles Ready Ration Dairy Feed	Coopersville	7.9	24.1	7.0	9.7	68.00	Same as B 3184.
B 3700	Union Grains Ubiko Biles Ready Ration Dairy Feed	Howell	8.7	24.0	5.5	9.7	67.00	Same as B 3184.
B 4013	Union Grains Ubiko Biles Ready Ration Dairy Feed	Coldwater	8.5	23.3	5.8	8.2	67.00	Same as B 3184.
B 4021	Union Grains Ubiko Biles Ready Ration Dairy Feed	Coldwater	8.9	23.9	5.7	10.3	66.80	Same as B 3184.
Average			8.5	23.8	6.0	9.5	.....
Wagner White Co., Inc., Jackson, Mich.								
Average			$\left\{ \begin{array}{l} G^* \\ F^* \end{array} \right.$	21.5	4.0	12.0	.....	Cottonseed meal, linseed meal, gluten feed, hominy feed, wheat bran and middlings, oats, salt.
B 4200	Cooperative Dairy Feed	Tecumseh	9.4	23.9	4.9	10.3	59.55	Same as B 4200.
B 4428	Cooperative Dairy Feed	Moreau	8.9	25.2	5.0	9.9	.....	Same as B 4200.
B 4410	Cooperative Dairy Feed	Dundee	8.5	22.2	4.3	10.4	64.00	Same as B 4200.
Average			8.7	23.7	4.7	10.2	.....
Golden Cream Dairy Feed								
Average			$\left\{ \begin{array}{l} G^* \\ F^* \end{array} \right.$	20.0	3.5	20.0	.....	Cottonseed meal, linseed meal, gluten feed, hominy feed, wheat bran, oat meal mill by-product, salt.
B 3406	Golden Cream Dairy Feed	Coopersville	9.2	20.7	3.7	15.4	58.00	Same as B 3406 without hominy feed.
B 3491	Golden Cream Dairy Feed	Vriesland	9.0	23.0	4.0	10.5	56.00	Same as B 3491.
B 3838	Golden Cream Dairy Feed	Wayland	9.2	22.9	4.8	13.4	55.00	Same as B 3491.
B 4003	Golden Cream Dairy Feed	Devereaux	8.1	19.4	4.8	15.6	.....	Same as B 3491 with middlings.
B 4917	Golden Cream Dairy Feed	Plymouth	8.4	21.8	4.8	16.1	58.00	Same as B 3406.
Average			8.8	21.6	4.4	14.2	.....
Wawco Dairy Feed								
Average			$\left\{ \begin{array}{l} G^* \\ F^* \end{array} \right.$	26.0	5.0	12.0	.....	Cottonseed meal, linseed meal, gluten feed, hominy feed, wheat bran, oats, salt.
B 3738	Wawco Dairy Feed	Mason	9.4	26.3	5.1	9.0	65.00	Same as B 3738.
B 4919	Wawco Dairy Feed	Plymouth	8.7	25.9	6.1	10.3	68.00	
Average			9.2	26.1	5.6	9.7	.....

E. L. Wellman, Grand Rapids, Mich.		$\left\{ \begin{array}{l} G^* \\ F^* \end{array} \right\}$		21.0		6.0		10.5			
Qualified Dairy Feed		$\left\{ \begin{array}{l} G^* \\ F^* \end{array} \right\}$		19.7		4.8		12.7		65.00	
B 3354	Qualified Dairy Feed			8.6		20.7		5.5		11.6	
B 3954	Qualified Dairy Feed			8.9		22.4		4.4		11.9	
B 4205	Qualified Dairy Feed			8.3		21.7		5.1		11.0	
B 4447	Qualified Dairy Feed			9.6		23.3		5.2		8.9	
B 4594	Qualified Dairy Feed			9.7		19.6		4.2		13.0	
B 4864	Qualified Dairy Feed			9.9		21.8		4.7		11.3	
B 4867	Qualified Dairy Feed			9.3		21.3		4.8		11.5	
Average				8.0		3.2		9.0			
Grand Rapids				8.9		8.8		3.7		10.3	
Grand Rapids											
B 4254	Grand Rapids										
B 4421	Grand Rapids										
B 4785	Grand Rapids										
Average				8.5		20.4		4.0		15.5	
Owosso											
Owosso				12.0		4.5		8.0			
Owosso				13.0		2.7		7.4		55.00	
(1918)											
B 3751	Howell			25.0		8.0		16.0			
B 4192	Adrian			9.2		26.3		5.7		15.2	
Average				7.8		27.6		5.4		14.3	
Average				8.5		27.0		5.6		11.8	
(1919)											
B 4126	Morenci			25.0		5.0		17.0			
B 3752	Howell			7.8		24.7		5.0		14.2	
B 4516	Escondido			10.0		10.0		3.5		12.0	
Average				11.0		9.7		3.2		11.8	
Average				13.9		9.7		3.3		7.5	
Average				12.5		9.7		3.3		9.7	
(1919)											
B 3331	Detroit			16.5		3.5		14.0			
B 3492	Grand Rapids			9.9		17.0		4.6		13.5	
Average				11.2		17.6		3.7		12.4	
Average											

Abbreviations for Guaranteed and Found.

Cottonseed meal, gluten feed, hominy feed, distillers' grains, wheat bran and middlings, oat meal mill by-products, calcium carbonate, salt.

Same as B 3854 without calcium carbonate.

Same as B 3954.

Same as B 3954.

Same as B 3954.

Same as B 3954 without hominy feed.

Same as B 3954.

Hominy feed, ground corn, oat meal mill by-products, calcium phosphate, salt.

Cottonseed meal, gluten feed, brewers' grains, wheat bran, ground corn, ground screenings, clipped oat by-product, salt.

Same as B 4254.

Wheat bran, oats, corn, velvet bean feed meal.

Cottonseed meal, linseed meal, distillers' grains, corn, palm kernel meal, peanut oil meal, cooked oat by-product, coconut oil meal, molasses, salt.

Same as B 3751 without corn, peanut oil meal, palm kernel meal.

Cottonseed meal, linseed meal, distillers' grains, coconut oil meal, clipped oat by-product, molasses, salt.

Distillers' grains, oats, corn, clipped oat by-product, molasses, salt.

Same as B 3752.

Cottonseed meal, gluten feed, distillers' grains, alfalfa meal, palm kernel meal, clipped oat by-product, ground screenings, molasses, salt.

Cottonseed meal, distillers' grains, corn meal, ground screenings, clipped oat by-product, coconut meal, molasses, calcium carbonate, salt.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
American Milling Co., Peoria, Ill.—Con.								
B 3818	Surene Dairy Feed.....	Holland.....	8.6	19.2	4.8	14.2	\$19.35	Same as B 3192.
B 4373	Surene Dairy Feed.....	Houghton.....	9.7	18.4	5.8	13.5	51.00	Same as B 3192 without salt and calcium carbonate.
B 4381	Surene Dairy Feed.....	Ladinton.....	9.6	18.6	5.0	12.6	2.75	Cottonseed meal, gluten feed, distillers' grains, clipped oat by-product, ground screenings, molasses, salt.
	Average.....		9.8	18.0	4.8	13.2		
B 4517	Tip Top Sugared Feed.....	Escanaba.....	{ G.* F.*	{ 12.0 17.4	{ 2.5 4.6	{ 14.0 11.9	49.00	Cottonseed meal, gluten feed, coconut oil meal, clipped oat by-product, ground screenings, molasses, salt.
Arctady Farms Milling Co., Chicago, Ill.								
B 3511	Arctady Dairy Feed.....	Marshall.....	{ G.* F.*	{ 16.0 17.4	{ 3.5 4.7	{ 15.0 11.5		Cottonseed meal, brewers' grains, malt sprouts, gluten feed, ground oat and grain by-products, molasses.
B 3792	Arctady Dairy Feed.....	Hartford.....	8.9 8.8	17.3 18.5	4.7 4.0	11.5 17.4	40.00 50.00	Cottonseed meal, distillers' grains, corn feed meal (trace), corn, ground screenings, ground clipped oat by-product, molasses.
B 3920	Arctady Dairy Feed.....	Carson City.....	9.0	15.5	4.7	15.3	46.00	Cottonseed meal, gluten feed, brewers' grains, malt sprouts, clipped oat by-product, ground grain screenings, molasses, salt.
B 2964	Arctady Dairy Feed.....	Itasca.....	7.4	15.3	4.3	15.5	48.00	Same as B 3921.
B 4868	Arctady Dairy Feed.....	Scottville.....	9.2	20.6	4.0	15.6	2.00	Same as B 3920.*
	Average.....		8.7	18.0	4.3	15.7		
B 3791	Producers Ready Ration.....	Hartford.....	{ G.* F.*	{ 19.0 21.9	{ 4.0 4.7	{ 11.0 12.7	57.00	Cottonseed meal, gluten feed, wheat bran and middlings, oat meal mill by-products, molasses, salt.
B 3763	J. E. Bartlett Co., Jackson, Mich. Farmer Brand Molasses Ration.....	Howell.....	{ G.* F.*	{ 16.0 14.0	{ 5.5 3.8	{ 16.0 13.5	48.00	Cottonseed meal, distillers' grains, oat meal mill by-products, velvet bean feed, ground grain screenings, molasses, calcium phosphate, salt.
B 4227	Champion Feed Milling Co., Lyons, Iowa. Champion Molasses Feed.....	Bingor.....	{ G.* F.*	{ 11.0 10.5	{ 1.5 3.5	{ 8.0 9.0	3.20	Cottonseed meal, wheat bran, ground corn, wheat screenings, ground flax, elarred peat, molasses.
B 3718	Honeysuckle Feed.....	Owosso.....	{ G.* F.*	{ 19.0 12.8	{ 0.5 0.9	{ 25.0 16.4	50.00	Alfalfa meal, molasses.
B 4858	Honeysuckle Feed.....	Manitowish.....	15.9 15.1	11.6 11.0	1.0 1.0	18.6 18.6	3.25	Same as B 3718.
	Average.....		15.5	12.2	1.0	17.5		

Dixie Mills Co., East St. Louis, Ill.									
B 3969	Diamond Dairy Feed.....		{ G.* F.* }	16.6 15.6	3.5 5.7	17.0 15.6	58.00	Cottonseed meal, clipped out by-product, ground grain screenings, molasses.	
Hales & Edwards Co., Chicago, Ill.									
B 3165	Gold Flake Dairy Feed.....	{ G.* F.* }	16.0 18.3	3.5 3.2	15.0 12.6	2.75 59.00	Cottonseed meal, linseed meal, gluten for l, clipped out by-product, ground screenings from wheat, barley and kafir, molasses, salt. Same as B 3165. Same as B 3165. Same as B 3165, with flaxseed screenings.		
B 3811	Gold Flake Dairy Feed.....		9.9	3.0	12.8	3.00			
B 4380	Gold Flake Dairy Feed.....		10.2	3.5	12.0	2.75			
B 4825	Gold Flake Dairy Feed.....		9.6	20.1	11.7	8.1			
International Sugar Feed Co., Minneapolis, Minn.									
B 4115	International Ready Ration Dairy Feed.....	Average	10.3	17.6	5.4	11.5		Cottonseed meal, wheat bran, gluten meal (trace), screenings, molasses, salt.	
B 4131	International Ready Ration Dairy Feed.....	{ G.* F.* }	21.0 11.1	5.5 19.9	5.0 4.8	10.8 10.0	3.15 3.00	Cottonseed meal, linseed meal, wheat bran, ground screenings, molasses, salt.	
B 4930	International Ready Ration Dairy Feed.....		9.5	17.9	5.9	14.4	2.65	Cottonseed meal, linseed meal, clipped out by-product, screenings, molasses.	
Interstate Feed Association, Toledo, Ohio.									
B 3156	International Special Dairy Feed.....	Average	10.7	19.5	5.4	11.7		Cottonseed meal, clipped out by-product, ground grain screenings, molasses, salt.	
B 3533	International Special Dairy Feed.....	{ G.* F.* }	15.0 11.9	4.5 15.0	4.6 11.5	15.0 14.2	50.00	Same as B 3156.	
B 4058	International Special Dairy Feed.....		9.7	13.8	4.0	18.3	4.8	Same as B 3156.	
B 4152	International Special Dairy Feed.....		8.2	14.6	5.4	11.9	49.00	Same as B 3156.	
B 4390	International Special Dairy Feed.....		10.5	16.7	5.4	12.1	2.90	Same as B 3156.	
B 4701	International Special Dairy Feed.....		9.4	15.2	5.5	15.9	2.50	Same as B 3156.	
B 4949	International Special Dairy Feed.....		8.6	15.8	5.1	16.3	2.50	Same as B 3156.	
Interstate Feed Association, Toledo, Ohio.									
B 3732	Normalik Ready Ration Dairy Feed.....	Average	10.0	15.2	4.9	15.8		Cottonseed meal, clipped out by-product, ground grain screenings, molasses, salt.	
B 3829	Normalik Ready Ration Dairy Feed.....	{ G.* F.* }	20.0 10.7	4.5 19.8	4.5 14.1	15.0 14.1	63.00	Same as B 3732 with wheat bran.	
B 3921	Normalik Ready Ration Dairy Feed.....		10.9	19.8	5.4	10.2	55.00	Same as B 3732 with linseed meal.	
B 4008	Normalik Ready Ration Dairy Feed.....		9.0	20.2	5.7	15.3	3.50	Same as B 3921.	
B 4024	Normalik Ready Ration Dairy Feed.....		9.6	19.6	4.3	16.6	3.50	Same as B 3732.	
B 4099	Normalik Ready Ration Dairy Feed.....		9.3	20.1	4.7	17.6	2.85	Same as B 3732.	
B 4075	Normalik Ready Ration Dairy Feed.....		9.4	20.1	5.1	15.3	2.90	Same as B 3732.	
B 4119	Normalik Ready Ration Dairy Feed.....		10.8	19.8	5.1	15.3	3.00	Same as B 3921.	
B 4306	Normalik Ready Ration Dairy Feed.....		11.3	20.0	5.2	15.0	2.90	Same as B 3921 with wheat bran.	
B 4306	Normalik Ready Ration Dairy Feed.....	Incoming.....	9.7	19.1	5.2	15.0	55.00	Same as B 3921.	
Chas. A. Krause Milling Co., Milwaukee, Wis.									
B 4876	Badger Dairy Feed.....	Average	10.1	19.8	5.1	14.7		Cottonseed meal, alfalfa meal, ground screenings, from wheat, oats and flax, molasses, salt.	
B 4979	Badger Dairy Feed.....	{ G.* F.* }	16.5 17.4	4.3 17.4	4.5 4.7	15.0 19.9	2.75 3.00	Same as B 4876.	
			11.3	17.4	4.7	19.9			
		Average.....	11.0	17.4	4.5	20.4			

Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Label number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Chas. A. Krause Milling Co., Milwaukee, Wis.—Con.								
876	Sweet Feed Dairy Feed	Manistee.....	G ⁸ 24.0 F ⁸ 24.7	3.7 4.1	15.0 13.2	83.00	Cottonseed meal, gluten feed, alfalfa meal, molasses, salt.	
62	Lichtenberg & Son, Detroit, Mich. Farmland Dairy Feed.	Detroit.....	G ⁸ 23.0 F ⁸ 22.1	4.0 4.8	12.0 11.2	60.00	Cottonseed meal, linseed meal, gluten meal, malt sprouts, wheat bran, molasses, salt.	
Omaha Alfalfa Milling Co., Omaha, Neb.								
B 1039	Cream Alfalfa Dairy Feed No. 1	Saginaw.....	G ⁸ 20.0 F ⁸ 19.5	3.0 3.1	18.0 12.1	60.00	Cottonseed meal, alfalfa meal, wheat bran, corn, molasses.	
B 4031	Green Meadow Dairy Feed	Saginaw.....	G ⁸ 11.0 F ⁸ 13.7	1.0 0.8	25.0 17.5	51.00	Alfalfa meal, molasses.	
B 4377	Green Meadow Dairy Feed	Houghton.....	15.2 11.3	0.8 0.8	20.1 16.2	2.50	Same as B 4031.	
B 4484	Green Meadow Dairy Feed	Mt. Morris.....	14.5 11.8	1.0 1.0	16.2	2.30	Same as B 4031.	
Purina Mills, St. Louis, Mo.								
B 3445	Purina Cow Chow Feed	Average.....	14.5 12.1	0.9 0.9	17.9	64.00	Cottonseed meal, linseed meal, gluten feed, hominy feed, alfalfa meal, molasses, salt.	
B 3706	Purina Cow Chow Feed	Grand Rapids.....	10.5 26.5	4.8 4.8	10.7	60.00	Same as B 3445.	
B 3949	Purina Cow Chow Feed	St. Johns.....	9.5 23.9	4.2 4.2	11.6 13.5	60.00	Same as B 3445.	
B 4114	Purina Cow Chow Feed	Kalamazoo.....	9.1 26.5	4.7 4.7	10.0 10.0	3.50	Same as B 3445.	
B 4137	Purina Cow Chow Feed	Sauk County.....	10.6 26.0	4.8 4.8	10.4 11.4	3.50	Same as B 3445.	
B 4223	Purina Cow Chow Feed	Crosswell.....	9.5 24.7	4.2 4.2	10.4 10.4	63.00	Same as B 3445.	
B 4457	Purina Cow Chow Feed	Benton Harbor.....	9.7 24.3	4.6 4.6	10.4 13.2	2.25	Same as B 3445 with corn.	
Quaker Oats Co., Chicago, Ill.								
B 3765	Blue Ribbon Dairy Feed	Average.....	9.8 25.1	4.6 4.6	11.5	61.00	Cottonseed meal, hominy feed, wheat bran, oat meal with by-products, calcium phosphate, molasses, salt.	
B 3785	Blue Ribbon Dairy Feed	Howell.....	G ⁸ 25.0 F ⁸ 22.8	5.0 5.4	14.0 13.2	65.00	Same as B 3765 with distillers' grains.	
B 4202	Blue Ribbon Dairy Feed	South Haven.....	8.8 22.2	5.0 5.1	12.9 14.0	63.00	Same as B 3765 with linseed meal and velvet bean feed.	
B 4409	Blue Ribbon Dairy Feed	Fremont.....	9.5 23.2	5.1 5.1	13.3 13.3	3.00	Same as B 3785.	
B 4967	Blue Ribbon Dairy Feed	Ann Arbor.....	10.6 21.8	5.7 5.7	13.3 13.5	62.50	Same as B 3785.	
Quaker Dairy Feed with Molasses								
B 3746	Quaker Dairy Feed with Molasses	Mt. Clemens.....	7.9 23.3	1.9 1.9	13.5	62.50	Cottonseed meal, distillers' grains, oat meal mill by-products, palm kernel oil meal, ground grain screenings, velvet bean feed, molasses, calcium phosphate, salt.	

B 4410	Quaker Dairy Feed with Molasses.	Ann Arbor	10.4	19.3	4.5	15.1	2.50	Same as B 3746 without velvet bean feed.
B 4909	Quaker Dairy Feed with Molasses.	Denton	13.5	15.3	4.6	15.1	2.25	Same as B 3746 without palm kernel oil meal and calcium phosphate.
		Average	11.5	16.9	4.3	15.2		
	E. L. Wellman, Grand Rapids, Mich.							
B 3173	Feeders Favorite Dairy Feed	Grand Rapids	8.1	18.0	1.1	13.6	41.00	Cottonseed meal, linseed meal, distillers' grains, wheat bran, palm kernel oil meal, oat meal mill by-products, ground grain attractants, molasses, calcium phosphate, salt.
B 3973	Feeders Favorite Dairy Feed	Exart	8.6	17.6	1.5	13.0	52.00	Same as B 3173 without linseed meal and wheat bran.
B 4111	Feeders Favorite Dairy Feed	Samsky	10.0	18.6	1.3	15.9	62.00	Same as B 3973.
		Average	9.3	18.1	1.6	14.5		
	Western Grain Products Co., Hammond, Ill.							
B 3190	Hammond Dairy Feed	Grand Rapids	9.8	17.8	4.8	12.7		Cottonseed meal, distillers' grains, malt sprouts, ground grain screenings, rolled oat by-product, molasses, salt.
B 3425	Hammond Dairy Feed	Nurica	10.2	16.9	1.3	15.2	50.00	Cottonseed meal, linseed meal, distillers' grains, molasses, salt.
B 3437	Hammond Dairy Feed	Jamestown	11.3	16.3	3.7	13.5	50.00	Same as B 3425 with alfalfa meal.
B 3952	Hammond Dairy Feed	Greenville	8.9	16.5	4.3	15.0		Same as B 3425.
B 3978	Hammond Dairy Feed	Conklin	10.4	18.2	5.0	13.8	52.00	Same as B 3425 with malt sprouts.
B 4420	Hammond Dairy Feed	Morcan	10.4	16.6	4.6	12.2	52.00	Same as B 3190.
B 4809	Hammond Dairy Feed	Gaylord	9.6	17.2	4.1	11.3	2.85	Same as B 3190.
B 4811	Hammond Dairy Feed	Boysie City	10.0	16.1	3.9	11.4	2.50	Same as B 3190.
B 4905	Hammond Dairy Feed	Chelsea	10.0	16.9	4.1	14.9	3.00	Same as B 3190.
		Average	10.1	17.0	4.3	14.0		
	HORSE FEEDS.							
	J. J. Badenech Co., Chicago, Ill.							
B 4411	Kurvyak Horse Feed	Ann Arbor	11.9	10.0	1.6	5.7	2.85	Oats, corn, barley.
	Caughy Jossman Co., Detroit, Mich.							
B 3360	Famabella Common Sense Horse Feed	Detroit	10.5	12.0	3.5	6.0	52.00	Oats, barley, cracked corn, oat hulls.
	Hales & Edwards Co., Chicago, Ill.							
B 3096	Excelsior Horse Feed	Lansing	11.1	9.8	3.8	5.4	3.40	Roll-d oats, rolled barley, cracked corn.
B 3810	Excelsior Horse Feed	Holland	11.2	10.9	3.1	4.0	64.00	Same as B 3096.
B 4586	Excelsior Horse Feed	Charlevoix	10.3	10.7	4.3	3.6	3.20	Same as B 3096.
		Average	11.0	10.2	3.7	5.0		
	Quaker Oats Co., Chicago, Ill.							
B 0939	Schwabacher Special Horse Feed	Birmingham	10.8	10.4	3.8	7.9	3.15	Oat meal mill by-products, corn, salt.
B 3197	White Diamond Feed	Grand Rapids	10.4	8.7	3.3	9.1	2.75	Hominy feed, ground corn, corn feed meal, oat meal mill by-products, salt.
B 3775	White Diamond Feed	South Haven	9.9	8.9	3.9	7.6	55.00	Same as B 3197 without corn feed meal, with calcium phosphate.
B 4093	White Diamond Feed	Elkton	10.5	8.9	3.2	8.2	65.00	Same as B 3197.

Abbreviations for Guaranteed and Found.

The brand listed below was licensed by the Famabella Co., whose business has been taken over by this company.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Quaker Oats Co., Chicago, Ill.—Corn.								
B 4240	White Diamond Feed	Niles.	9.9	8.6	3.3	8.2	\$25.00	Same as B 3197 with ground kafir and calcium phosphate.
B 4822	White Diamond Feed	Maneedom.	10.1	9.1	3.5	7.7	2.90	Hominy feed, oat meal mill by-products, ground corn, calcium phosphate, salt.
B 4855	White Diamond Feed	Manistee.	10.5	8.9	4.4	7.8	3.00	Hominy feed, oat meal mill by-products, ground corn, barley, salt.
E. L. Wellman, Grand Rapids, Mich.								
B 3171	Qualified Horse Feed	Average.	10.3	8.9	3.7	8.1		Hominy feed, ground corn, oat meal mill by-product, calcium phosphate, salt.
B 3124	Qualified Horse Feed	(1918) { G. F.	9.7	8.6	3.3	9.0	56.00	Same as B 3171.
B 3094	Qualified Horse Feed	Grand Rapids.	10.6	8.8	3.8	6.2	3.15	Same as B 3171 without hominy feed.
		Elkton.	10.2	8.9	3.9	7.3	75.00	Same as B 3171.
MOLASSES HORSE FEEDS.								
B 4475	Qualified Horse Feed	Average.	10.2	8.8	3.7	7.8		Same as B 3171.
B 4502	Qualified Horse Feed	(1919) { G. F.	10.3	9.3	4.1	6.5	3.75	Same as B 3171 with barley.
B 4823	Qualified Horse Feed	East Jordan.	11.2	9.2	3.5	4.6	3.25	Same as B 3171 with barley.
		Maneedom.	11.3	9.6	3.6	4.2	3.40	Same as B 3171 with barley.
AMERICAN MILLING CO., PEORIA, ILL.								
B 3341	Peoria Horse Feed	Average.	10.9	9.4	3.7	5.2		Corn, alfalfa meal, oats, oat meal mill by-products, molasses, salt.
B 3657	Peoria Horse Feed	{ G. F.	14.3	10.0	2.5	14.0	53.00	Same as B 3341 without oat meal mill by-products.
B 3729	Peoria Horse Feed	Detroit.	13.6	9.4	3.0	10.7	53.50	Same as B 3657.
B 3650	Peoria Horse Feed	Detroit.	11.6	10.0	3.0	11.4	54.00	Same as B 3341.
B 4379	Peoria Horse Feed	Grand Rapids.	15.7	9.2	2.9	12.3	60.00	Same as B 3341.
		Hancock.	15.0	10.5	2.1	15.9	60.00	Same as B 3341.
MOLASSES HORSE AND MULE FEED.								
B 4357	Succene Horse and Mule Feed	Average.	14.0	9.6	2.8	12.5		Oats, corn, oat meal mill by-products, molasses, salt.
B 3342	Succene Horse Feed with Alfalfa	{ G. F.	13.4	8.5	5.8	10.0	3.30	Corn, oats, barley, alfalfa meal, molasses, salt.
B 3816	Succene Horse Feed with Alfalfa	{ G. F.	14.3	10.2	3.4	8.6	58.00	Same as B 3342 without salt.
B 4345	Succene Horse Feed with Alfalfa	Holland.	12.3	10.7	3.1	8.8	61.35	Same as B 3342 without salt.
		Escondido.	14.3	9.8	3.1	7.0	58.50	Same as B 3342 without barley.
		Average.	13.6	10.2	3.4	8.1		

Aracy Farms Milling Co., Chicago, Ill.		(1918)	(62)						
B 3502	Country Gentleman Horse Feed	Detroit	{ P.	15.1	9.0	2.6	15.0		Alfalfa meal, oats, corn, molasses.
B 4711	Country Gentleman Horse Feed	Rochester	{ P.	6.2	12.8	2.7	17.2	51.00	Same as B 3502.
	Average			10.7	12.1	3.1	18.2		
J. J. Badenoch Co., Chicago, Ill.		(1919)	(62)						
B 1108	Country Gentleman Horse Feed	Jackson	{ P.	14.0	9.0	1.5	15.0	2.40	Same as B 3502.
	Average			14.0	11.4	2.9	15.0		
Albert Dickinson Co., Chicago, Ill.		(62)							
B 3724	Glendon Horse Feed	Owosso	{ P.	11.7	11.0	2.0	15.0	60.00	Alfalfa meal, oats, corn, molasses.
B 4221	Glendon Horse Feed	Calumet	{ P.	13.8	10.6	2.3	12.2	60.00	Same as B 3722 with barley.
B 4320	Glendon Horse Feed	Plymouth	{ P.	13.6	11.6	2.6	11.7	35.50	Same as B 3722 with barley.
	Average			11.0	11.1	2.3	13.1		
Hales & Edwards Co., Chicago, Ill.		(62)							
B 3801	Hobby Horse Feed	Holland	{ P.	14.3	12.0	2.5	15.0	61.00	Alfalfa meal, oats, corn, molasses.
B 4042	Hobby Horse Feed	Madison	{ P.	12.3	11.6	1.9	13.4	61.00	Same as B 3801.
B 4888	Hobby Horse Feed	Alkaska	{ P.	13.8	11.6	2.0	13.4	3.00	Same as B 3801.
B 4831	Hobby Horse Feed	Traverse City	{ P.	13.0	11.7	2.1	13.9	3.20	Same as B 3801.
	Average			13.4	11.7	2.1	13.3		
Hales & Edwards Co., Chicago, Ill.		(62)							
B 4826	Harvest Horse Feed	Kelleysville	{ P.	11.7	11.9	2.3	12.2	3.00	Alfalfa meal, oats, cracked corn, barley, molasses.
B 4800	Harvest Horse Feed	Mansfield	{ P.	13.8	12.4	2.5	12.0	3.00	Same as B 4826.
	Average			11.3	12.2	2.4	12.1		
Chas. A. Krause Milling Co., Milwaukee, Wis.		(62)							
B 4587	Kingdella Horse Feed	Charlevoix	{ P.	13.6	11.8	2.5	11.5	5.00	Alfalfa meal, oats, cracked corn, barley, molasses.
B 4910	Kingdella Horse Feed	Wayne	{ P.	16.8	12.7	2.9	10.5		Same as B 4586.
	Average			15.2	12.3	2.7	11.0		
Chas. A. Krause Milling Co., Milwaukee, Wis.		(62)							
B 3425	Badger Horse Feed	Grand Haven	{ P.	15.5	10.3	2.1	12.2	3.50	Alfalfa meal, oats, corn, molasses.
B 3831	Badger Horse Feed	Holland	{ P.	13.3	10.3	2.3	12.2	62.00	Same as B 3425.
B 4492	Badger Horse Feed	Ypsilanti	{ P.	11.1	9.8	2.3	11.3	3.00	Same as B 3425.
B 4811	Badger Horse Feed	Traverse City	{ P.	13.0	11.1	2.1	12.1	2.00	Same as B 3425.
B 4945	Badger Horse Feed	Detroit	{ P.	16.1	10.8	2.0	13.8	52.00	Same as B 3425.
	Average			11.8	10.5	2.3	12.5		

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
B 3177 B 4944	Chas. A. Krause Milling Co., Milwaukee, Wis.—Con. Krause Horse Feed Krause Horse Feed	Hudsonville.....	{ G^* F^* }	{ 10.0 10.5 }	{ 2.5 2.1 }	{ 10.0 5.9 }	{ \$63.00 53.00 }	Corn, oats, alfalfa meal, molasses, salt. Same as B 3177.
		Detroit.....	{ F^* F^* }	{ 15.5 11.5 }	{ 2.4 2.4 }	{ 11.5 8.7 }		
		Average.....	12.5	11.0	2.3	8.7		
B 3778 B 4236	N. R. G. Horse Feed N. R. G. Horse Feed	South Haven.....	{ G^* F^* }	{ 10.0 10.8 }	{ 3.0 3.1 }	{ 10.0 7.9 }	{ 60.00 3.60 }	Alfalfa meal, oats, corn, molasses, salt. Same as B 3778 without alfalfa meal.
		Paw Paw.....	{ F^* F^* }	{ 9.6 11.3 }	{ 4.3 7.6 }			
		Average.....	12.0	11.1	3.7	7.8		
B 3342	Pul-Mor Horse Feed	Detroit.....	{ G^* F^* }	{ 9.0 8.7 }	{ 1.0 1.6 }	{ 16.0 16.0 }	{ 50.00 50.00 }	Oats, corn, alfalfa meal, oat meal and by-products, fax plant refuse, molasses.
		(1918) Detroit.....	{ G^* F^* }	{ 16.8 9.5 }	{ 3.5 3.9 }	{ 8.0 8.0 }		
		(1919) Detroit.....	{ G^* F^* }	{ 10.0 10.7 }	{ 3.0 3.8 }	{ 10.0 6.4 }		
B 3781	Omaha Alfalfa Milling Co., Omaha, Neb. Alcorno Horse Feed	South Haven.....	{ G^* F^* }	{ 10.0 10.9 }	{ 2.0 2.2 }	{ 12.0 12.1 }	{ 55.00 55.00 }	Alfalfa meal, oats, corn, molasses.
		Kalamazoo.....	{ G^* F^* }	{ 10.0 11.4 }	{ 2.0 1.9 }	{ 12.0 11.5 }	{ 66.00 66.00 }	
		(1918) Saginaw.....	{ G^* F^* }	{ 10.0 10.7 }	{ 2.0 2.5 }	{ 12.0 12.7 }		
B 4031 B 4325 B 4513	Peerless Horse Feed Peerless Horse Feed Peerless Horse Feed	Sault Ste. Marie.....	{ F^* F^* }	{ 10.5 17.7 }	{ 12.8 9.9 }	{ 61.90 61.90 }		Alfalfa meal, oats, corn, molasses, charcoal. Same as B 4034 without charcoal. Same as B 4325.
		Escanaba.....						
		Average.....	13.4	11.1	2.2	2.0		
B 3643 B 3654 B 4376	Peerless Horse Feed Peerless Horse Feed Peerless Horse Feed	Detroit.....	{ G^* F^* }	{ 9.0 10.4 }	{ 1.5 2.5 }	{ 18.0 11.2 }	{ 61.00 3.25 }	Alfalfa meal, oats, corn, molasses. Same as B 3643. Same as B 3643.
		Houghton.....						
		Average.....	14.5	10.0	2.6	10.7		

Purina Mills, St. Louis, Mo.		South Haven, Mich.		Grand Rapids, Mich.		Hartford, Conn.		Hartford, Conn.		Grand Rapids, Mich.		Average		Alfalfa meal, oats, corn, molasses.	
B 3782	Perfection Horse Feed														
B 3981	Perfection Horse Feed														Same as B 3782.
B 3800	Good Luck Feed with Molasses.														Alfalfa meal, oats, corn, molasses, salt.
B 3796	Purina O-Molene Feed														Alfalfa meal, oats, corn, molasses.
B 3926	Purina O-Molene Feed														Same as B 3796 with salt.
POULTRY FEEDS.															
Amendt Milling Co., Monroe, Mich.															
B 4729	Amco Chick Feed														Wheat, hulled oats, cracked corn, kafir, milo, millet, grit.
B 4465	Amco Poultry Mash														Linsed meal, gluten feed, neat scraps, wheat bran and middlings, oat feed, corn feed meal, dried milk.
B 4495	Amco Poultry Mash														Same as B 4465 without dried milk, with charcoal and salt.
B 4728	Amco Poultry Mash														Same as B 4495 without charcoal.
B 4534	Amco Scratch Grain														Linsed cake, wheat, oats, cracked corn, kafir, milo, buckwheat, barley, wheat screenings, sunflower, charcoal.
B 4731	Amco Scratch Grain														Same as B 4534 without sunflower and charcoal.
B 4924	Amco Scratch Grain														Same as B 4731.
B 4548	Amco Scratch Grain with Grit														Same as B 4534.
B 4450	Amco Scratch Grain with Grit														Same as B 4534 with grit.
American Milling Co., Peoria, Ill.															
B 3339	Chick Chuck Scratch Feed														Wheat, oats, corn, kafir, buckwheat, barley, unflower.
B 3375	Chick Chuck Scratch Feed														Same as B 3339.
B 3375	Chick Chuck Scratch Feed														Same as B 3339.
B 3318	Chick Chuck Scratch Feed														Same as B 3339.
B 3543	Chick Chuck Scratch Feed														Same as B 3339.
B 3507	Chick Chuck Scratch Feed														Same as B 3339.
B 3574	Chick Chuck Scratch Feed														Same as B 3339.
B 3582	Chick Chuck Scratch Feed														Same as B 3339.
B 3731	Chick Chuck Scratch Feed														Same as B 3339.
B 3940	Chick Chuck Scratch Feed														Same as B 3339 without buckwheat.
B 4365	Chick Chuck Scratch Feed														Same as B 3339.
B 4901	Chick Chuck Scratch Feed														Same as B 3339.

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
American Milling Co., Peoria, Ill.—Con.								
B 3379	Chick Chick Scratch Feed with 5 per cent grit.	Detrit. (G.* F.*	10.0 12.6	10.0 9.8	2.5 2.6	2.0 2.0	\$9.65	Same as B 3379 with grit.
B 3756	Sucree's Chick Feed	Detrit. (G.* F.*	13.9 13.9	9.8 9.8	3.6 3.6	2.3 2.3	4.00	Wheat, corn, kafir, millets.
B 3341	Sucree's Poultry Mash	Detrit. (G.* F.*	10.5 10.5	18.3 18.3	4.1 4.1	5.3 5.3	3.25	Lined meal, cod scrap, alfalfa meal, corn feed meal, wheat bran
B 3373	Sucree's Poultry Mash	Detrit. (G.* F.*	10.3 10.3	18.1 18.1	5.0 5.0	6.6 6.6	4.00	Shred buttermilk, calcium carbonate, salt.
	Average		10.5	18.2	4.9	6.0		Same as B 3341.
B 3340	Sucree's Scratch Feed	Detrit. (G.* F.*	12.9 12.9	9.9 9.9	2.8 2.8	5.0 5.0	3.80	Wheat, oats, corn, kafir, buckwheat, barley, sunflower.
B 3380	Sucree's Scratch Feed	Detrit. (G.* F.*	11.9 11.9	10.3 10.3	3.2 3.2	5.8 5.8	4.50	Same as B 3379.
B 4112	Sucree's Scratch Feed	Detrit. (G.* F.*	11.8 11.8	9.6 9.6	3.7 3.7	3.1 3.1	4.00	Same as B 3340 without buckwheat and sunflower.
	Average		12.0	9.9	2.9	2.8		
B 3679	Tip Top Scratch Feed	Detrit. (G.* F.*	12.5 12.5	10.9 10.9	3.8 3.8	2.9 2.9	3.30	Wheat, oats, corn, kafir, wild buckwheat, barley, sunflower.
B 4361	Tip Top Scratch Feed	Detrit. (G.* F.*	12.8 12.8	9.8 9.8	3.3 3.3	2.9 2.9	3.35	Same as B 3679.
	Average		12.7	10.1	3.6	2.9		
B 3378	Tip Top Scratch Feed with 5 per cent grit.	Detrit. (G.* F.*	11.5 11.5	9.4 9.4	3.0 3.0	2.1 2.1	3.50	Same as B 3679 with grit.
B 4518	Tip Top Scratch Feed with 5 per cent grit.	Detrit. (G.* F.*	12.6 12.6	10.5 10.5	3.7 3.7	4.0 4.0	3.20	Same as B 3679 with grit.
	Average		12.1	10.0	3.4	3.2		
Arady Farms Milling Co., Chicago, Ill.								
B 4765	Arady's Chick Feed	Detrit. (G.* F.*	9.0 9.0	9.9 9.9	3.1 3.1	2.5 2.5	5.00	Wheat, oats, cracked corn, kafir, millets, charcoal, grit.
B 4802	Arady's Chick Feed	Detrit. (G.* F.*	11.4 11.4	11.0 11.0	3.5 3.5	2.1 2.1	4.00	Same as B 4765 without grit and charcoal.
	Average		13.3	10.5	3.3	2.1		
B 3790	Arady's Poultry Feed	Detrit. (G.* F.*	12.9 12.9	9.0 9.0	2.0 2.0	5.0 5.0		Wheat, oats, cracked corn, kafir, buckwheat, barley, sunflower.
B 4491	Arady's Poultry Feed	Detrit. (G.* F.*	12.1 12.1	10.2 10.2	3.1 3.1	3.1 3.1	3.96	Same as B 3790.
B 4802	Arady's Poultry Feed	Detrit. (G.* F.*	12.3 12.3	10.2 10.2	4.0 4.0	4.0 4.0	3.55	Same as B 3790.
B 4905	Arady's Poultry Feed	Detrit. (G.* F.*	12.3 12.3	10.1 10.1	3.0 3.0	3.7 3.7	3.75	Same as B 3790 without oats.
B 4957	Arady's Poultry Feed	Detrit. (G.* F.*	11.6 11.6	10.2 10.2	3.1 3.1	3.3 3.3	3.60	Same as B 3790.
	Average		12.3	10.1	3.2	3.7		

Bad Axe Grain Co., Bad Axe, Mich.									
1-4085	Egg Brand Scratch Feed	Bad Axe	{ G ^o F ^o	11.7	10.0 10.6	2.5 2.7	5.0 4.1	3.00	Wheat, oats, corn, buckwheat, barley.
J. J. Badenoch Co., Chicago, Ill.									
1-3673	Daily Egg Poultry Feed no grit	Lansing	{ G ^o F ^o	11.7	9.5	2.5	5.0		Wheat, corn, kafir, milo, barley, soybean wheat, sunflower.
1-3669	Daily Egg Poultry Feed with grit	Lansing	{ G ^o F ^o	10.7	9.3	2.3	3.8	3.50	Wheat, oats, cracked corn, kafir, milo, wild buckwheat, barley weed seeds, grit, shell.
1-3674	Cer-Lay Poultry Feed no grit	Lansing	{ G ^o F ^o	9.5	9.5	2.5	5.0		Wheat, oats, cracked corn, buckwheat, barley, milo, sunflower.
1-4337	Cer-Lay Poultry Feed no grit	Paw Paw	{ G ^o F ^o	11.4	9.8	3.4	3.2	3.90	Same as B 3674 with kafir.
1-4018	Cer-Lay Poultry Feed no grit	Plymouth	{ G ^o F ^o	11.2	9.8	3.1	3.0	4.00	Same as B 1257.
	Average			11.5	9.8	3.3	3.2		
1-4022	Daily Egg Chick Feed with grit	Benton Harbor	{ G ^o F ^o	11.0	9.5	2.5	5.0		Wheat, cracked corn, kafir, milo, grit, millet.
1-3700	Egg-Lay Poultry Feed with grit	Lansing	{ G ^o F ^o	10.5	9.3	2.4	4.0	3.10	Wheat, oats, corn, kafir, milo, wild buckwheat, barley, sunflower, sweatmeal, weed seeds, grit, shell.
1-3779	Bar's Chicken Feed	Pontiac	{ G ^o F ^o	11.1	8.8	3.0	3.0	3.50	Soybean wheat, oats, cracked corn, kafir, milo, hard wheat, barley, sunflower.
Blatford Calf Meal Factory, Waukegan, Ill.									
1-3603	Blatford's Bar-Nu Laying Mash	Grand Rapids	{ G ^o F ^o	10.9	10.0	5.0	8.0		Meat scraps, alfalfa meal, wheat bran, fish scraps, coconut meal, barley, powdered bone meal, oat meal, oat hulls, corn feed meal.
1-3697	Blatford's Bar-Nu Laying Mash	Lansing	{ G ^o F ^o	9.1	19.7	5.9	8.1	4.40	Barley, powdered lime stone, salt.
1-4338	Blatford's Bar-Nu Laying Mash	Traverse City	{ G ^o F ^o	8.8	19.1	8.1	8.5	4.00	Same as B 3402 without oat hulls. Same as B 3697.
	Average			9.5	19.2	6.1	8.5		
1-3715	Blatford's Fill the Basket Egg Mash	Detroit	{ G ^o F ^o	9.4	19.0	4.0	10.0		Cottonseed meal, linseed meal, meat scraps, bone meal, blood flour, alfalfa meal, wheat flour, wheat bran, ground oats, flaxseed, rice polish, dried milk, barley and malt sprouts meal, ground peas and beans, coconut meal, oat groats, oat hulls, corn meal, fish, caperum, f. enriched, breast bean meal, powdered lime- stone, animal salt.
1-3716	Blatford's Fill the Basket Egg Mash	South Haven	{ G ^o F ^o	9.3	19.1	4.5	9.4	3.75	Same as B 3715 with wheat middlings.
1-3717	Blatford's Fill the Basket Egg Mash	Grand Rapids	{ G ^o F ^o	9.0	21.3	4.6	8.7	4.20	Same as B 3716.
	Average			9.2	20.3	4.5	8.9		
1-3719	Blatford's Milk Mash	Detroit	{ G ^o F ^o	10.8	20.0	4.0	7.5		Cottonseed meal, linseed meal, meat scraps, bone meal, blood flour wheat flour, wheat middlings, oat meal, flaxseed, ground beans and peas, rice polish, coarsened meal, coconut meal, dried milk, corn meal, barley and malt sprout meal, fish, powdered lime- stone, bone-meal, animal salt.

Abbreviations for Guaranteed and Formed.
(Millet added by dealer.

ANALYSIS OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Blatchford Calf Meal Factory, Waukegan, Ill.—Con.								
B 4140	Blatchford's Milk Mash	Adrian	9.7	22.0	1.8	6.0	\$2.20	Same as B 3346.
B 1065	Blatchford's Milk Mash	Pontiac	9.2	22.1	5.3	6.1	3.25	Same as B 3346.
Average.								
			9.9	22.5	1.8	5.8		
Bonfield & Calvin, Bay City, Mich.								
B 4054	Pure Grain Scratch Feed	Bay City	12.6	9.3	2.5	5.0	3.60	
				9.6	2.9	3.5		
Caro Poultry Feed.								
B 4072	Caro Poultry Feed.	Caro	13.0	10.0	2.5	5.0	4.25	Wheat, oats, corn, buckwheat, barley.
*Caughy Jossman Co., Detroit, Mich.								
B 3727	CCC Scratch Feed	Detroit	10.6	9.3	2.5	2.2	3.60	Wheat, oats, cracked corn, buckwheat, barley, grit.
B 4772	Common Sense Baby Chick Feed	Detroit	11.2	10.0	2.5	5.0	5.00	Wheat, cracked corn, kafir, milo, millet, wild seed.
B 3372	Common Sense Developing Feed	Detroit	10.8	9.8	2.1	2.5	3.80	Wheat, corn, kafir, buckwheat, milo, millet, peas.
B 3558	Common Sense Developing Feed	Detroit	12.0	10.0	2.3	2.4	1.15	Wheat, oats, cracked corn, kafir, milo, buckwheat, barley, weed seeds.
Average.								
			11.4	9.9	2.2	2.5		
Common Sense Lge. Mash.								
B 3363	Common Sense Lge. Mash.	Detroit	10.5	15.0	3.5	10.2	3.15	Corn feed meal, corn bran, wheat bran and middlings, oat hulls, meat scraps, alfalfa meal.
B 3359	Common Sense Pigeon Feed No. 1	Detroit	11.7	11.3	2.2	2.8	4.75	Wheat, cracked corn, kafir, buckwheat, millet, peas.
B 3754	Common Sense Pigeon Feed No. 1	Detroit	11.8	10.7	2.2	2.5	1.60	Same as B 3369.
Average.								
			11.8	11.0	2.5	2.7		
B 3337	Common Sense Pigeon Feed No. 3	Detroit	11.7	11.3	2.2	3.8	5.00	Wheat, corn, kafir, buckwheat, peas, millet.
B 3370	Common Sense Pigeon Feed No. 3	Detroit	11.5	12.2	2.7	3.9	4.85	Same as B 3337.
B 3735	Common Sense Pigeon Feed No. 3	Detroit	11.5	12.1	2.7	3.2	4.70	Same as B 3337.
Average.								
			11.6	12.2	2.7	3.6		
B 3371	Common Sense Pigeon Feed No. 6	Detroit	12.2	12.0	2.4	3.0	4.95	Wheat, kafir, buckwheat, millet, peas.
B 3380	Common Sense Pigeon Feed No. 6	Detroit	12.1	12.6	2.5	4.3	4.95	Same as B 3371.

B 3522	Common Sense Pigeon Feed No. 6	11.8	12.6	2.4	3.7	3.10	Same as B 3371.
B 3554	Common Sense Pigeon Feed No. 6	11.8	12.8	4.3	3.6	3.45	Same as B 3371 with barley and mulo.
B 3621	Common Sense Pigeon Feed No. 6	11.4	13.7	2.6	2.9	3.50	Same as B 3371.
B 3736	Common Sense Pigeon Feed No. 6	11.9	11.5	2.5	3.4	4.80	Same as B 3371.
Average		11.9	12.4	2.8	3.6	.....
B 3367	Common Sense Scratch Feed	11.8	9.5	2.5	2.7	3.3	Wheat, oats, cracked corn, kafir, buckwheat, barley, sunflower.
B 3597	Common Sense Scratch Feed	11.8	11.1	2.6	3.7	3.35	Same as B 3367 without sunflower.
B 3517	Common Sense Scratch Feed	11.8	10.0	2.7	3.2	3.95	Same as B 3367.
B 3553	Common Sense Scratch Feed	11.8	9.8	3.9	4.2	4.00	Same as B 3367.
B 3580	Common Sense Scratch Feed	12.1	9.9	3.3	3.7	4.15	Same as B 3367 without oats and with peas.
B 3617	Common Sense Scratch Feed	11.3	10.8	3.3	4.0	4.90	Same as B 3367 without sunflower with peas.
B 3728	Common Sense Scratch Feed	11.3	10.8	3.3	3.2	3.90	Same as B 3367 without wheat and sunflower.
B 3732	Common Sense Scratch Feed	11.3	10.2	2.9	3.6	3.80	Same as B 3367 with mulo.
B 3732	Common Sense Scratch Feed	12.1	9.8	3.1	3.5	3.45	
Average		11.7	10.3	3.0	3.6	.....
B 3368	Common Sense Scratch Feed No. 2	11.2	9.7	2.6	3.2	3.25	Wheat, cracked corn, kafir, buckwheat, barley, sunflower, shell, grit.
B 3647	Common Sense Scratch Feed No. 2	10.2	10.2	2.2	3.3	3.45	Wheat, oats, corn, kafir, buckwheat, barley, grit.
B 3733	Common Sense Scratch Feed No. 2	11.5	9.8	2.3	3.4	3.35	Same as B 3647.
Average		11.0	9.9	2.4	3.4	.....
B 4310	Cereal Mills Co., Wausau, Wis.	11.2	10.4	2.7	2.8	3.75	Wheat, oats, corn, kafir, buckwheat, barley, sunflower, grit.
B 4623	Chamberlain's Perfect Chick Feed	10.1	10.0	2.5	6.0	7.00	Wheat, oatmeal, kafir, mulo, meat scraps, grain screenings, wood seeds, charcoal, grit.
B 4640	Chamberlain's Perfect Chick Feed	10.4	11.8	4.2	5.2	.....	Same as B 4623.
Average		10.3	11.7	4.1	5.3	.....
B 4057	Plymouth Rock Scratch Feed	11.1	10.0	3.5	7.0	3.40	Wheat, oats, corn, buckwheat, early, sunflower, grit.
B 4067	Plymouth Rock Scratch Feed	12.3	9.8	3.1	4.2	4.00	Same as B 4057 with screenings.
Average		11.7	10.0	3.4	5.1	.....
B 3384	Henkel's Poultry Feed	11.0	9.0	2.4	3.0	4.00	Wheat, cracked corn, buckwheat, kafir, mulo, hemp, screenings, grit.
B 3391	Henkel's Poultry Feed	10.5	8.8	3.1	2.6	3.20	Same as B 3384 without kafir and hemp.
B 3505	Henkel's Poultry Feed	11.8	9.3	3.3	3.0	3.35	Same as B 3384 without hemp.
B 3551	Henkel's Poultry Feed	10.6	9.2	3.5	3.2	3.80	Same as B 3505.
B 3649	Henkel's Poultry Feed	10.8	9.1	3.8	3.1	3.50	Same as B 3391.
B 3726	Henkel's Poultry Feed	10.1	9.1	3.9	3.1	3.80	Same as B 3505.
B 4817	Henkel's Poultry Feed	11.5	10.0	4.0	3.0	3.90	Same as B 3505 with sunflower.
Average		10.9	9.3	3.6	3.0	.....

The brands listed below were licensed by the Farnabella Co., whose business has been taken over by this company.

*Abbreviations for Guaranteed and Found.

B 3380	Globe Egg Mash.....	{ G* F* }	15 0	3 0	10 0	3 65	Linsed cake, meat scraps, alfalfa meal, wheat bran and molasses.
B 3383	Globe Egg Mash.....		11 4	22 5	4 6	3 60	corn feed meal, corn bran, salt.
B 3499	Globe Egg Mash.....		11 4	16 6	3 5	3 50	Same as B 3380.
B 3544	Globe Egg Mash.....		11 1	18 9	3 8	3 50	Same as B 3380.
B 3560	Globe Egg Mash.....		10 4	21 1	4 5	3 75	Same as B 3380.
B 3571	Globe Egg Mash.....		10 5	21 9	5 3	3 37	Same as B 3380.
B 3579	Globe Egg Mash.....		10 6	22 2	4 7	3 80	Same as B 3380.
B 3579	Globe Egg Mash.....		10 4	20 9	4 5	4 00	Same as B 3380.
B 3633	Globe Egg Mash.....		9 5	20 7	4 9	3 30	Same as B 3380.
B 3650	Globe Egg Mash.....		10 5	19 9	5 0	3 50	Same as B 3380.
	Average.....		10 6	20 6	4 5	.....
B 3541	Globe Pigeon Feed no grit.....	{ G* F* }	10 0	2 5	5 0	5 50	Wheat, kafir, buckwheat, peas, millet, hemp.
B 3730	Globe Pigeon Feed no grit.....		11 2	12 0	3 0	5 35	Same as B 3541.
B 4720	Globe Pigeon Feed no grit.....		10 8	13 8	3 5	4 80	Same as B 3541.
	Average.....		11 0	12 9	3 3	.....
B 3378	Globe Scratch Feed no grit.....	{ G* F* }	10 0	10 5	2 5	4 50	Linsed cake, wheat, oats, corn, kafir, buckwheat, barley, sunflower, wild buckwheat.
B 3535	Globe Scratch Feed no grit.....		12 0	10 5	2 5	4 05	Same as B 3378 without wild buckwheat.
B 3542	Globe Scratch Feed no grit.....		11 4	10 4	3 0	3 95	Same as B 3535.
B 3597	Globe Scratch Feed no grit.....		11 5	11 0	3 0	5 00	Same as B 3535 with milo.
B 3608	Globe Scratch Feed no grit.....		11 9	10 6	3 0	4 20	Same as B 3535.
B 3650	Globe Scratch Feed no grit.....		12 4	10 3	2 7	4 00	Same as B 3535.
B 3660	Globe Scratch Feed no grit.....		12 1	10 2	2 6	3 50	Same as B 3535.
B 3886	Globe Scratch Feed no grit.....		11 8	10 4	2 8	3 95	Same as B 3535.
B 4359	Globe Scratch Feed no grit.....		11 9	11 0	2 9	4 00	Same as B 3535.
	Average.....		11 9	10 6	2 9	.....
B 3807	Globe Scratch Feed with grit.....	{ G* F* }	10 0	2 5	5 0	3 50	Same as B 3535 with grit.
B 3853	Globe Scratch Feed with grit.....		11 5	9 9	3 1	2 80	Same as B 3807.
B 4329	Globe Scratch Feed with grit.....		11 0	11 1	2 8	3 85	Same as B 3807.
	Average.....		12 1	10 3	3 1	.....
	Average.....		11 5	10 4	2 9	.....
B 3255	King Pigeon Feed no grit.....	{ G* F* }	10 0	2 5	5 0	4 50	Wheat, corn kafir, buckwheat, millet, peas, hemp.
B 4719	King Pigeon Feed no grit.....		10 4	10 9	3 4	3 50	Same as B 3255.
	Average.....		11 3	10 8	3 4	.....
	Average.....		10 9	10 9	3 4	.....
B 3757	Pine Tree Chick Feed no grit.....	{ G* F* }	10 0	2 5	5 0	4 50	Wheat, corn, kafir, millet.
	Average.....		12 0	9 3	3 1	.....
B 4598	Pine Tree Chick Feed with grit.....	{ G* F* }	10 0	2 5	5 0	3 60	Same as B 3757 with grit.
	Average.....		10 4	2 3	1 8	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	(Crude protein.	(Crude fat.	(Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Albert Dickinson Co., Chicago, Ill.—Con.								
B 2889	Pine Tree Scratch Feed no grit.	G.*	10.0	2.2	3.0	3.0	33.90	Wheat, oats, corn, kafir, buckwheat, barley, sunflower.
B 4317	Pine Tree Scratch Feed no grit.	F.*	11.3	10.4	3.4	3.6	4.00	Same as B 3880.
B 4390	Pine Tree Scratch Feed no grit.		12.3	10.0	2.9	3.8	3.50	Same as B 3880.
B 4753	Pine Tree Scratch Feed no grit.		11.7	10.5	3.3	3.6	3.50	Same as B 3880.
	Pine Tree Scratch Feed no grit.		12.9	10.1	3.5	3.8		Same as B 3880 without sunflower.
	Average		12.1	10.3	3.3	3.7		
B 2876	Pine Tree Scratch Feed with grit.	G.*	10.0	2.2	3.0	3.0		Same as B 3880 with grit.
B 2880	Pine Tree Scratch Feed with grit.	F.*	11.0	9.7	3.1	3.1	3.57	Same as B 3876.
B 4364	Pine Tree Scratch Feed with grit.		10.7	9.7	2.8	3.0	3.75	Same as B 3876.
	Pine Tree Scratch Feed with grit.		11.3	11.0	2.9	2.8	3.50	Same as B 3876.
	Average		11.0	10.1	2.9	3.0		
B 4350	Queen Poultry Mash	G.*	11.0	2.5	10.0	10.0		Alfalfa meal, wheat, wheat bran and middlings, corn feed meal, corn bran, meat scraps.
B 2877	Rival Scratch Feed no grit.	F.*	10.6	12.3	4.3	8.1	3.10	Wheat, oats, corn, kafir, wild buckwheat, barley.
B 4723	Rival Scratch Feed no grit.	G.*	11.3	9.5	2.3	2.0	3.57	Same as B 3877 with wood seeds.
	Rival Scratch Feed no grit.	F.*	10.3	11.8	4.1	5.6	3.40	
	Average		10.8	11.7	3.8	5.0		
B 2875	Rival Scratch Feed with grit.	G.*	9.5	2.3	2.3	2.0		Same as B 3877 with grit.
B 4051	Rival Scratch Feed with grit.	F.*	10.7	10.5	3.1	4.3	3.42	Same as B 3875.
B 4383	Rival Scratch Feed with grit.		10.1	10.5	3.0	4.0	3.55	Same as B 3875.
B 4894	Rival Scratch Feed with grit.		9.5	10.7	3.1	3.5	3.75	Same as B 3875 with screenings.
	Rival Scratch Feed with grit.		10.9	11.3	3.4	4.1	3.50	Same as B 3875 with wood seeds.
	Average		10.3	10.6	3.2	4.0		
B 4047	White Cross Chick Feed with grit.	G.*	10.0	2.3	2.0	2.0		Wheat, corn, kafir, millet, grit.
B 4322	White Cross Chick Feed with grit.	F.*	10.3	9.2	2.2	1.4	3.75	Same as B 4047 with wild buckwheat.
B 4355	White Cross Chick Feed with grit.		11.1	12.3	2.8	3.0	4.00	Same as B 4047.
B 4888	White Cross Chick Feed with grit.		11.7	10.9	2.5	3.1	3.70	Same as B 4047.
	White Cross Chick Feed with grit.		11.3	10.7	2.4	2.7	4.25	Same as B 4047.
	Average		11.1	10.8	2.7	2.6		
B 2172	White Cross Scratch Feed no grit.	G.*	10.0	2.5	2.0	2.0		Wheat, oats, corn, kafir, buckwheat, barley, sunflower.
B 2618	White Cross Scratch Feed no grit.	F.*	11.0	10.3	2.9	3.0	3.80	Same as B 3172.
B 3648	White Cross Scratch Feed no grit.		11.7	10.5	2.9	3.9	4.00	Same as B 3172.
	White Cross Scratch Feed no grit.		12.1	10.3	3.0	3.1	3.90	Same as B 3172.

B 3701	White Cross Scratch Feed no grit.....	Lausang.....	11.8	10.4	3.1	3.4	3.90	Same as B 3172.
B 3702	White Cross Scratch Feed no grit.....	Lausang.....	12.2	10.1	2.7	3.2	3.90	Same as B 3172.
B 3725	White Cross Scratch Feed no grit.....	Detroit.....	11.6	10.2	2.8	3.4	3.80	Same as B 3172.
	Average.....		11.6	10.3	2.9	3.3		
		$\left. \begin{array}{l} G^* \\ F^* \end{array} \right\}$		10.0	2.5	5.0		
B 3752	White Cross Scratch Feed with grit.....	Detroit.....	11.1	9.5	2.5	2.7	4.00	Same as B 3172 with grit.
		$\left. \begin{array}{l} G^* \\ F^* \end{array} \right\}$		10.0	2.5	5.0		
B 4321	Wisconsin Poultry Ration.....	Cheloveyan.....	11.5	10.7	3.2	3.4	4.25	Wheat, oats, corn, kafir, milo, buckwheat, barley, linseed cake, sunflower.
B 4179	Standard A Poultry Feed.....	Reading.....	12.4	9.6	2.5	2.7	1.25	Wheat, oats, corn, kafir, buckwheat, barley, millet, sunflower.
		$\left. \begin{array}{l} G^* \\ F^* \end{array} \right\}$		9.5	2.5	5.0		
		$\left. \begin{array}{l} G^* \\ F^* \end{array} \right\}$		10.0	2.5	5.0		
B 4289	Cackle Poultry Feed no grit.....	Coopersville.....	11.5	11.1	2.1	1.8	3.50	Cracked wheat, cracked corn, cracked kafir, millet.
B 4613	Cackle Poultry Feed no grit.....	Grand Rapids.....	12.0	11.5	2.9	1.7	3.60	Same as B 4289.
B 4759	Cackle Poultry Feed no grit.....	Jackson.....	12.2	8.9	2.2	1.6		Same as B 4289.
	Average.....		12.1	10.2	2.6	1.7		
B 3683	Cackle Poultry Feed with grit.....	Lausang.....	11.3	10.4	2.6	1.7	4.00	Same as B 4289 with grit and weed seeds.
B 3428	Cackle Poultry Feed no grit.....	Nunica.....	12.5	10.2	2.3	2.9		Wheat, oats, cracked corn, kafir, barley, sunflower.
B 3374	Cackle Poultry Feed no grit.....	Grand Rapids.....	12.0	10.4	2.8	2.8	3.80	Same as B 3428.
B 3637	Cackle Poultry Feed no grit.....	Detroit.....	11.7	10.1	2.7	2.7	3.45	Same as B 3428.
B 3679	Cackle Poultry Feed no grit.....	Lausang.....	12.6	9.5	2.6	3.0	3.85	Same as B 3428.
B 4571	Cackle Poultry Feed no grit.....	Cheloveyan.....	11.5	11.4	2.5	1.2	3.50	Same as B 3125.
	Average.....		12.1	10.3	2.8	3.1		
B 4630	College Scratch Feed.....	Grand Rapids.....	11.5	10.8	3.3	2.3	3.55	Wheat, oats, cracked corn, kafir, buckwheat, barley.
B 3498	Morning Glory Scratch Feed no grit.....	Grand Rapids.....	12.6	10.7	2.9	3.5	3.80	Wheat, oats, cracked corn, kafir, wild buckwheat, barley, sunflower.
B 3473	Morning Glory Scratch Feed no grit.....	Grand Rapids.....	11.5	11.3	2.9	3.4	3.70	Same as B 3498 with weed seeds.
B 3530	Morning Glory Scratch Feed no grit.....	Detroit.....	11.6	11.6	2.4	3.4	3.50	Same as B 3498.
B 3840	Morning Glory Scratch Feed no grit.....	Detroit.....	11.6	10.9	3.1	4.1	3.85	Same as B 3498 with weed seeds.
B 3692	Morning Glory Scratch Feed no grit.....	Lausang.....	12.1	9.6	2.7	3.1	3.75	Same as B 3498 with weed seeds and grit.
	Average.....		11.9	10.8	2.8	3.1		

Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Hales & Edwards Co., Chicago, Ill.—Con.								
B 3604	Morning Glory Scratch Feed with grit and shell.	Marshall	{ G.* F.*	9.0	2.0	7.0	84.50	Wheat, oats, cracked corn, kafir, wild buckwheat, barley, and flower, weed seeds, grit, shell.
B 4382	Morning Glory Scratch Feed with grit and shell.	Harroet	11.6	10.1	6.0	7.3	3.20	Same as B 3604 without weed seeds.
B 4872	Morning Glory Scratch Feed with grit and shell.	Lansington	11.9	12.6	2.8	3.3	3.75	Same as B 3604 without weed seeds.
		Average.....	11.0	11.1	3.9	4.8		
B 3523	Pound Squab Pigeon Feed no grit.	Detroit	{ G.* F.*	9.0	2.0	7.0	4.25	Wheat, cracked corn, kafir, buckwheat, peas, milled, hemp.
B 2577	Pound Squab Pigeon Feed no grit.	Detroit	12.1	11.4	2.7	2.8	3.96	Same as B 3523.
B 3641	Pound Squab Pigeon Feed no grit.	Detroit	11.3	11.0	3.0	3.0	4.10	Same as B 3523 without corn.
B 3681	Pound Squab Pigeon Feed no grit.	Lansing	12.2	11.6	3.4	3.6	4.25	Same as B 3523.
		Average.....	12.4	10.8	2.7	2.4	4.25	Same as B 3523.
B 3524	Red Comb Course Chick Feed no grit.	Detroit	{ G.* F.*	12.0	3.0	3.0		Wheat, cracked corn, kafir, hulled oats, millet, grit.
B 2682	Red Comb Course Chick Feed no grit.	Lansing	11.2	9.9	2.5	1.9	3.96	Same as B 3524.
B 4581	Red Comb Course Chick Feed no grit.	Charlevoix	11.6	8.9	2.4	1.6	3.50	Same as B 3524 without grit.
B 4611	Red Comb Course Chick Feed no grit.	Grand Rapids	12.5	10.4	2.8	1.8	3.60	Same as B 3524.
		Average.....	12.1	11.3	3.0	2.0		
B 4620	Red Comb Fine Chick Feed no grit.	Detroit	11.9	10.1	2.7	1.8		Cracked wheat, cracked corn, steel cut oats, millet, kafir.
B 4770	Red Comb Fine Chick Feed no grit.	Grand Rapids	{ G.* F.*	10.0	2.5	5.0	1.00	Same as B 4620 without weed seeds.
		Average.....	13.2	9.9	2.6	1.7	5.50	
B 3636	Red Comb Crate Fatener with dried buttermilk.	Detroit	12.2	9.9	2.7	1.8		Alfalfa meal, wheat middlings, oat flour, barley flour, red dog flour, corn feed meal, dried buttermilk, meat scraps.
B 3869	Red Comb Crate Fatener with dried buttermilk.	Holland	{ G.* F.*	15.0	4.0	8.0	4.00	Same as B 3636 without meat scraps.
		Average.....	10.1	13.7	5.8	5.2	4.45	
B 3410	Red Comb Mash Feed with dried buttermilk and shell.	Grand Rapids	10.8	12.4	4.4	4.1		Unseeded meal, alfalfa meal, wheat bran, ground oats, corn feed meal, meat scraps, dried buttermilk, salt, grit, shell.
B 3521	Red Comb Mash Feed with dried buttermilk and shell.	Detroit	{ G.* F.*	15.0	4.0	10.0	3.90	Same as B 3410 with middlings and without salt.
B 3612	Red Comb Mash Feed with dried buttermilk and shell.	Detroit	10.3	10.9	4.2	7.9	3.60	Same as B 3521 without grit.
B 3690	Red Comb Mash Feed with dried buttermilk and shell.	Lansing	9.8	17.8	4.7	6.7	3.50	Same as B 3521 without grit.
B 3812	Red Comb Mash Feed with dried buttermilk and shell.	Holland	10.7	16.4	4.0	6.3	3.90	Same as B 3521 without grit.
		Average.....	13.0	11.4	3.2	8.9	3.75	Same as B 3521 without grit.

B 4584	Red Comb Mash Feed with dried buttermilk and shell.	Charlevoix.....	9.4	17.2	4.6	7.4	3.75	Same as B 3521 without grit.
		Average.....	10.5	17.2	4.5	7.4		
		(1918) { <i>G</i> * { <i>F</i> * Detroit.....	10.8	9.0	2.0	7.0		Wheat, oats, corn, kafir, buckwheat, barley, sudanlow.
B 3376	Red Comb Poultry Feed no grit.....		10.8	10.6	2.8	3.5	3.95	Same as B 3376 with grit.
B 3387	Red Comb Poultry Feed no grit.....		12.6	12.2	3.4	3.4	4.25	Same as B 3376.
B 3388	Red Comb Poultry Feed no grit.....		12.3	11.1	2.7	2.5	4.25	Same as B 3376.
B 3409	Red Comb Poultry Feed no grit.....		12.5	10.7	2.2	2.5	3.90	Same as B 3376.
B 3484	Red Comb Poultry Feed no grit.....		12.5	9.8	3.5	2.7	3.90	Same as B 3376.
B 3529	Red Comb Poultry Feed no grit.....		12.6	9.8	3.5	3.0	3.60	Same as B 3376.
B 3535	Red Comb Poultry Feed no grit.....		12.2	9.3	2.6	3.3	4.05	Same as B 3376 with milo.
B 3583	Red Comb Poultry Feed no grit.....		12.6	9.9	2.7	3.4	4.00	Same as B 3376.
B 3594	Red Comb Poultry Feed no grit.....		11.8	10.1	3.1	3.3	4.85	Same as B 3376.
B 3653	Red Comb Poultry Feed no grit.....		11.9	10.4	2.9	3.3	1.25	Same as B 3376.
B 3681	Red Comb Poultry Feed no grit.....		12.5	9.8	2.7	2.8	3.90	Same as B 3376.
		Average.....	12.2	10.5	2.8	3.1		
		(1919) { <i>G</i> * { <i>F</i> * Charlevoix.....	12.6	10.4	2.8	2.1		Wheat, oats, cracked corn, kafir, buckwheat, barley, sudanlow.
B 4582	Red Comb Poultry Feed no grit.....		12.6	10.4	2.8	2.1		
B 3513	Red Comb Poultry Feed with grit.....		12.0	10.4	2.3	3.3	3.50	Wheat, oats, cracked corn, kafir, buckwheat, barley, sudanlow.
B 3549	Red Comb Poultry Feed with grit.....		11.5	10.1	3.0	3.1	3.90	Same as B 3513 with milo.
		Average.....	11.8	10.3	2.7	3.2		
B 3867	Harris Milling Co., Mt. Pleasant, Mich. Scratch Feed.....		11.5	10.6	3.2	4.0	3.20	Oats, cracked corn, buckwheat, barley, wheat screenings, and flower.
		{ <i>G</i> * { <i>F</i> * Mt. Pleasant.....	10.0	10.0	2.5	5.0		
B 4960	B. B. Hyde, Port Huron, Mich. Ideal Poultry Feed.....		11.4	10.7	2.8	4.6	1.00	Wheat, oats, cracked corn, kafir, buckwheat, barley, charbon.
		{ <i>G</i> * { <i>F</i> * Port Huron.....	11.4	9.8	2.9	4.0		
B 3962	Ithaca Roller Mills, Ithaca, Mich. Renown Poultry Feed.....		10.2	11.3	2.7	4.6		Oats, cracked corn, kafir, buckwheat, barley, wheat screenings.
		{ <i>G</i> * { <i>F</i> * Ithaca.....	11.4	2.3	3.1			
B 4605	Chas. A. Krause Milling Co., Milwaukee, Wis. Badger Laying Mash.....		9.8	18.0	3.2	10.0	3.60	Hominy feed, meat scraps, alfalfa meal, wheat bran and middings, red dog flour, corn germ meal, corn feed meal.
B 4974	Blue Top Scratch Feed no grit.....		13.8	17.8	5.0	9.6		
B 4024	Conservation Chick Feed no grit.....		13.8	17.8	5.0	9.6		Wheat, oats, corn, kafir, buckwheat, barley, sudanlow.
B 4977	Conservation Chick Feed no grit.....		12.0	10.4	3.3	2.8	1.00	Wheat, cracked corn, kafir, milo, millet.
		{ <i>F</i> * { <i>F</i> * Mt. Clemens.....	13.9	10.5	3.0	2.5	4.00	Same as B 4621.
		Average.....	12.5	10.5	3.2	2.7		
B 4976	Conservation Developing Feed no grit.....		14.1	10.1	3.4	5.1	1.00	Cracked corn, kafir, milo, buckwheat, millet.

* Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Chas. A. Krause Milling Co., Milwaukee, Wis.—Con.								
B 3517	Conservation Scratch Feed no grit	Detroit (1918) { G. ^o } (1919) { F. ^o }	12.0 10.1	10.0 9.0	2.5 3.1	5.0 3.2	\$4.00	Oats, corn, kafir, buckwheat, barley, sunflower.
B 3538	Conservation Scratch Feed no grit	Holland { G. ^o } { F. ^o }	11.2 9.6	9.6 3.1	3.1 3.4	3.5 3.4	3.70	Same as B 3517.
B 4559	Conservation Scratch Feed no grit	Mammoth { G. ^o } { F. ^o }	11.3 9.6	9.6 3.1	3.1 3.4	3.5 3.4	3.50	Same as B 3517.
Average.....								
(1918) { G. ^o } (1919) { F. ^o }								
B 3192	Conservation Scratch Feed with grit	Grand Rapids { G. ^o } (1919) { F. ^o }	12.1 9.0	10.0 9.0	2.5 2.5	5.0 5.0	.....	Same as B 3517 with grit.
B 3680	Conservation Scratch Feed with grit	Lansing { G. ^o } { F. ^o }	10.8 9.1	9.1 2.4	2.4 3.5	3.5 3.5	3.65	Same as B 3517 with mlo, grit.
B 3742	Conservation Scratch Feed with grit	Mason { G. ^o } { F. ^o }	10.7 9.1	9.1 2.4	2.4 3.8	3.5 3.7	4.25	Same as B 3517 with mlo, grit.
Average.....								
(1918) { G. ^o } (1919) { F. ^o }								
B 3432	Krause Scratch Feed no grit	Grand Haven { G. ^o } { F. ^o }	11.9 10.6	10.0 11.4	2.1 2.9	5.0 1.5	.....	Wheat, oats, corn, kafir, buckwheat, barley, sunflower.
B 3451	Krause Scratch Feed no grit	Zeeland { G. ^o } { F. ^o }	12.6 11.4	10.0 11.5	3.0 3.6	3.6 3.2	3.90	Same as B 3432 with seed seeds.
B 3888	Krause Scratch Feed no grit	Muskegon { G. ^o } { F. ^o }	11.1 10.0	9.9 3.0	3.0 3.1	3.1 3.0	4.00	Same as B 3432.
B 3951	Krause Scratch Feed no grit	Belding { G. ^o } { F. ^o }	11.7 10.6	9.9 2.5	3.0 3.2	3.2 3.0	3.60	Same as B 3432 with mlo.
B 4001	Krause Scratch Feed no grit	Zeeland { G. ^o } { F. ^o }	12.4 10.6	10.6 3.2	3.2 3.1	3.1 3.0	3.60	Same as B 3432.
B 4810	Krause Scratch Feed no grit	Traverse City { G. ^o } { F. ^o }	12.8 10.3	10.0 2.8	2.2 3.4	3.0 3.4	3.70	Same as B 3432.
Average.....								
(1918) { G. ^o } (1919) { F. ^o }								
B 3431	Krause Scratch Feed with grit	Grand Haven { G. ^o } { F. ^o }	12.1 11.4	10.3 8.9	2.8 2.3	3.4 2.7	3.80	Same as B 3432 with mlo and grit.
Larroe Milling Co., Detroit, Mich.								
B 4477	Low Cabin Scratch Feed	Holly { G. ^o } { F. ^o }	12.1 10.6	10.0 10.6	2.5 3.1	6.0 3.9	4.00	Wheat, cracked corn, kafir, buckwheat, barley, sunflower.
B 4590	Low Cabin Scratch Feed	Wayne { G. ^o } { F. ^o }	13.9 10.3	10.3 3.4	3.4 3.1	3.1 3.0	3.90	Same as B 4477 with mlo.
B 4965	Low Cabin Scratch Feed	Mc Clelland { G. ^o } { F. ^o }	11.7 9.8	9.8 3.0	3.0 3.0	3.0 3.0	1.80	Same as B 4477 with mlo.
Average.....								
(1918) { G. ^o } (1919) { F. ^o }								
B 4780	Crest Brand Poultry Feed	Port Huron { G. ^o } { F. ^o }	10.1 10.8	8.0 10.8	2.0 3.1	5.0 4.1	3.90	Wheat, oats, corn, kafir, mlo, buckwheat, barley.
Michigan Milling Co., Ann Arbor, Mich.								
B 4416	Minico Scratch Feed	Ann Arbor { G. ^o } { F. ^o }	12.7 11.9	12.7 12.6	2.8 2.8	4.9 5.0	2.90	Wheat, oats, corn, buckwheat, screenings.

New Century Co. of Michigan, Detroit, Mich.											
B 3559	Cadillac Scratch Feed no grit	G.*	9.5	2.5	5.0	3.45	Wheat, oats, corn, kafir, wild buckwheat, barley, grain screenings, weed seeds.				
B 3615	Cadillac Scratch Feed no grit	F.*	12.3	11.9	3.0	1.3	3.45				
B 3724	Cadillac Scratch Feed no grit	F.*	11.3	10.9	3.1	1.0	4.50				
Average			11.5	11.6	3.0	3.9					
B 3558	Cadillac Scratch Feed with grit	G.*	9.5	2.5	5.0	3.46	Same as B 3559 with grit.				
B 3557	New Century Scratch Feed no grit	F.*	10.5	10.6	2.7	3.5	3.50				
B 3576	New Century Scratch Feed no grit	G.*	11.8	10.6	2.5	5.0	3.50				
B 3622	New Century Scratch Feed no grit	F.*	12.1	10.1	3.0	3.3	4.25				
B 3646	New Century Scratch Feed no grit	F.*	11.6	10.4	3.1	3.1	4.00				
B 3655	New Century Scratch Feed no grit	F.*	11.6	10.0	2.8	2.9	4.15				
		F.*	11.3	9.8	2.8	3.1	4.50				
Average			11.7	10.2	2.9	3.3					
Northrup King & Co., Minneapolis, Minn.											
B 4395	Special Scratch Feed	G.*	10.0	2.5	5.0	3.50	Wheat, oats, corn, milo, barley, hulled speltz, weed seeds, grit.				
B 4387	Sterling Chick Feed	F.*	11.0	11.3	2.9	3.3	3.75				
B 4378	Sterling Egg Mash	G.*	11.1	10.9	3.5	3.2	3.85				
B 4511	Sterling Scratch Feed no grit	F.*	9.7	10.0	5.0	10.0	3.15				
B 4538	Sterling Scratch Feed	G.*	12.2	11.3	3.4	2.7	3.75				
B 4542	Sterling Scratch Feed	F.*	10.9	11.0	2.9	3.6	3.15				
		F.*	11.5	10.1	3.2	3.2					
Average			11.2	10.6	3.1	3.4					
North Star Feed & Cereal Co., Minneapolis, Minn.											
B 4338	Scratch Feed	G.*	10.0	2.5	10.0	2.7	1.50				
		F.*	10.4	10.3	3.2	2.7					
Omaha Alfalfa Milling Co., Omaha, Neb.											
B 3188	Egg-size Scratch Feed	G.*	10.0	3.5	4.0		Oats, cracked corn, kafir, buckwheat, barley, sunflower, wheat screenings.				
B 3780	Egg-size Scratch Feed	F.*	11.4	10.2	3.1	4.0	3.50				
B 4326	Egg-size Scratch Feed	F.*	12.5	9.5	2.9	3.3	3.90				
		F.*	11.9	9.8	3.5	3.0					
Average			11.9	9.8	3.3	3.4					
Park & Pollard Co., Chicago, Ill.											
B 3833	Baby Buster Chick Feed	G.*	11.0	2.0	5.0		Wheat, cracked corn, kafir, milo, millet, oats, shredded fish.				
B 4628	Baby Buster Chick Feed	F.*	12.1	15.7	3.4	1.9	1.00				
B 4764	Baby Buster Chick Feed	F.*	12.5	14.9	1.1	2.0					
		F.*	12.5	14.9	3.8	2.1					
Average			11.9	14.5	3.8	2.1					

Abbreviations for Guaranteed and Feeds

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Park & Pollard Co., Chicago, Ill.—Con.								
B 3357	Growing Feed	{ G* F* }	10.0	15.0	1.5	8.0	83.80	Wheat, oats, ground corn, kafir, barley, buckwheat, wheat bran and middlings, alfalfa meal, meat, bone, calcium carbonate, salt
B 3419	Growing Feed		14.1	3.2	3.2	7.4	3.85	Same as B 3357.
B 3362	Growing Feed		10.7	15.8	3.2	6.4	3.85	Same as B 3357.
B 3381	Growing Feed		10.7	12.8	2.9	5.5	4.00	Same as B 3357 without alfalfa meal.
B 4286	Growing Feed		11.1	16.6	3.2	5.6	3.75	Same as B 3357 without alfalfa meal.
		Traverse City	10.6	12.4	3.6	6.2	3.85	Same as B 3357.
		Average	10.6	14.3	3.2	6.2	.....
B 4502	Intermediate Chick Feed	{ G* F* }	10.0	15.0	1.5	5.0	.....	Wheat, oats, cracked corn, kafir, milo, buckwheat, millet.
B 4307	Intermediate Chick Feed		12.6	9.8	3.7	2.3	4.50	Same as B 4502.
B 4638	Intermediate Chick Feed		13.4	10.0	3.2	2.5	3.75	Same as B 4502.
		Grand Rapids	12.7	10.2	3.4	3.4	.....
		Average	12.9	10.0	3.4	2.7	.....
B 3556	Lay or Bust Dry Mash	{ G* F* }	18.0	15.0	1.5	12.0	.....	Meat, bone, alfalfa meal, wheat bran and middlings, oats, corn, kafir, buckwheat, barley, fish, calcium carbonate, salt.
B 3418	Lay or Bust Dry Mash		9.4	19.4	3.5	8.6	3.70	Alfalfa meal, wheat bran and middlings, oats, corn, kafir, fish
		Grand Rapids	8.9	19.6	2.8	10.7	3.85	neat, bone, salt, glass, calcium carbonate.
B 3468	Lay or Bust Dry Mash	{ G* F* }	18.4	18.4	3.8	8.5	3.75	Same as B 3356 with wheat, without oats.
B 3509	Lay or Bust Dry Mash		9.1	18.3	3.5	9.6	4.50	Same as B 3356 with wheat.
B 3671	Lay or Bust Dry Mash		9.4	19.2	4.6	8.1	4.00	Same as B 3356 w h wheat.
B 3835	Lay or Bust Dry Mash		10.4	18.3	4.5	7.2	3.65	Same as B 3356 with wheat.
B 3937	Lay or Bust Dry Mash		9.1	16.9	3.0	10.2	3.90	Same as B 3356 with wheat.
B 4044	Lay or Bust Dry Mash		8.7	17.2	4.2	10.2	4.00	Same as B 3356 with wheat and dried beet pulp.
B 4204	Lay or Bust Dry Mash		9.9	22.6	4.7	9.1	3.75	Same as B 3356 without buckwheat.
B 4501	Lay or Bust Dry Mash		9.6	16.9	4.9	7.4	3.50	Same as B 3356 with wheat, without meat scraps.
		East Jordan	9.5	18.7	4.0	9.0	.....
		Average	9.5	18.7	4.0	9.0	.....
B 3187	Pontiac Scratch Feed	{ G* F* }	10.0	15.0	1.5	5.0	.....	Wheat, oats, cracked corn, kafir, milo, buckwheat, barley.
B 3253	Pontiac Scratch Feed		11.2	9.9	3.2	4.0	4.00	Same as B 3187.
B 3469	Pontiac Scratch Feed		11.1	10.1	2.8	3.8	3.85	Same as B 3187.
B 4221	Pontiac Scratch Feed		12.5	9.9	2.9	3.9	3.75	Same as B 3187.
B 4412	Pontiac Scratch Feed		12.5	10.5	3.0	3.1	4.00	Same as B 3187.
B 4412	Pontiac Scratch Feed		13.3	10.3	3.2	2.9	3.90	Same as B 3187.
B 4500	Pontiac Scratch Feed		12.4	10.3	3.6	4.3	3.75	Same as B 3187.
		East Jordan	12.4	10.3	3.6	4.3	.....
		Average	12.2	10.2	3.1	3.7	.....

B 3607	Red Ribbon Chick Feed	Marshall	{ G* F* }	10.0 11.9	2.0 2.9	5.0 2.0	Wheat, oats, cracked corn, kafir, milo, millet.
B 4203	Red Ribbon Chick Feed	Grand Rapids	{ G* F* }	10.6 11.5	2.9 3.5	2.1 4.0	Same as B 3607.
B 4327	Red Ribbon Chick Feed	Grand Rapids	{ G* F* }	10.6 12.2	3.0 3.9	2.2 5.00	Same as B 3607.
B 4756	Red Ribbon Chick Feed	Jackson	{ G* F* }	10.0 13.0	3.0 4.0	1.9 2.9	Same as B 3607.
	Average			12.2	3.3	2.1	
B 3666	Red Ribbon Scratch Feed	Lansing	{ G* F* }	10.0 12.0	1.5 3.2	5.0 3.6	Wheat, oats, cracked corn, kafir, milo, buckwheat, barley, sunflower.
B 3417	Screened Scratch Feed	Grand Rapids	{ G* F* }	10.0 11.0	1.5 2.6	4.00 3.85	Wheat, oats, cracked corn, kafir, buckwheat, barley, milo, sunflower.
B 3505	Screened Scratch Feed	Allison	{ G* F* }	10.3 11.7	3.3 3.3	3.2 4.1	Same as B 3417.
B 3826	Screened Scratch Feed	Holland	{ G* F* }	10.3 11.5	3.3 3.1	5.00 3.70	Same as B 3417.
B 4205	Screened Scratch Feed	Grand Rapids	{ G* F* }	10.3 12.1	3.4 3.4	3.6 3.50	Same as B 3417.
B 4569	Screened Scratch Feed	Charlevoix	{ G* F* }	10.1 11.1	2.8 3.7	3.7 3.50	Same as B 3417.
	Average			11.5	3.0	3.6	
B 4733	Peters' Red Feather Scratch Poultry Feed	Wyandotte	{ G* F* }	10.0 11.2	3.0 3.3	6.0 2.8	Wheat, cracked corn, kafir, milo, buckwheat, barley, sunflower.
B 4263	Chicken Feed	Battle Creek	{ G* F* }	8.0 10.9	1.0 2.3	17.0 5.1	Wheat, oats, corn, screenings:
B 3677	Pratt's Baby Chick Food	Lansing	{ G* F* }	11.5 10.1	3.5 4.0	3.8 3.4	Wheat middlings oat shorts, corn meal, millet, rye, bone meal, soluble starch, Epsom salts, calcium carbonate.
B 3624	Purina Chicken Chowder Feed with charcoal	Grand Rapids	{ G* F* }	19.0 10.2	4.1 4.1	9.4 9.4	Linseed meal, gluten meal, meat scraps, blood meal, alfalfa meal, wheat middlings, corn feed meal, charcoal, salt.
B 4025	Purina Chicken Chowder Feed with charcoal	Jonesville	{ G* F* }	19.1 10.0	4.6 19.1	9.0 3.75	Same as B 3624.
B 4145	Purina Chicken Chowder Feed with charcoal	Crowell	{ G* F* }	19.1 10.1	4.9 19.1	8.8 3.90	Same as B 4025.
B 4988	Purina Chicken Chowder Feed with charcoal	Brown City	{ G* F* }	18.8 9.1	5.5 18.8	10.0 4.40	Same as B 4025.
	Average			9.9	4.5	9.3	
B 3627	Purina Chicken Fatena	Grand Rapids	{ G* F* }	9.0 10.4	5.0 7.4	9.0 7.6	Linseed meal, wheat middlings, corn germ meal, ground oats, ground corn, ground kafir, ground sunflower.
B 4503	Purina Chick Feed	Gladwin	{ G* F* }	10.0 11.2	2.5 2.9	4.0 2.2	Wheat, corn, kafir, millet.
B 3446	Purina Scratch Feed	(1918) Grand Rapids	{ G* F* }	10.0 12.9	4.0 3.2	4.0 2.9	Wheat, oats, corn, kafir, milo, buckwheat, barley, sunflower.
B 3546	Purina Scratch Feed	Detroit	{ G* F* }	10.1 11.8	3.0 3.1	2.8 2.8	Same as B 3446.
B 3707	Purina Scratch Feed	Harford	{ G* F* }	10.7 12.2	3.0 3.0	2.8 4.50	Same as B 3446.
B 4007	Purina Scratch Feed	Three Rivers	{ G* F* }	10.4 11.5	3.1 3.1	5.00 3.1	Same as B 3446.
B 4009	Purina Scratch Feed	Union City	{ G* F* }	10.4 11.5	3.0 3.0	5.00 3.1	Same as B 3446.
B 4135	Purina Scratch Feed	Crowell	{ G* F* }	10.1 12.0	2.8 3.6	3.6 4.25	Same as B 3446.

*Abbreviations for Guaranteed and Found.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Purina Mills, Ralston Purina Co., St. Louis, Mo. - Con.								
B 3444	Purina Scratch Feed	Brown City	11.9	10.3	3.4	3.4	\$1.25	Same as B 3446.
B 3456	Purina Scratch Feed	Litchfield	12.7	10.8	2.8	3.5	1.25	Same as B 3446.
	Average		12.1	10.4	3.0	3.2		
Quaker Oats Co., Chicago, Ill.								
B 4712	Purina Scratch Feed	1919) { G. ⁺ F. ⁺ Rochester	10.0 11.7	10.0 11.0	2.5 3.0	5.0 3.5	3.75	Same as B 3416, without milo and oats.
B 4958	Big Egg Scratch Grains no grit	Port Huron	11.7	10.0	2.5	5.0	4.00	Wheat, corn, kafir, milo, barley, sunflower, screenings.
B 3872	Early Bird Chick Feed no grit	Lansing	13.2	10.1	3.8	2.2		Wheat, bulled oats, cracked corn, kafir, milo, wild buckwheat, millet, weed seeds, charcoal.
B 4960	Early Bird Chick Feed with grit	Lansing	12.1	10.0	3.7	2.9		Same as B 3872 with grit.
B 3784	Ful-O-Pop Dry Mash	South Haven	9.7	12.4	5.7	8.9	3.75	Cottressed meal, gluten feed, hominy feed, meat scraps, lone meal.
B 3821	Ful-O-Pop Dry Mash	Holland	9.2	10.9	5.9	8.8	4.00	alfalfa meal, fish, ground grain screenings.
B 3844	Ful-O-Pop Dry Mash	Wayland	9.1	20.3	5.3	9.0	4.00	Same as B 3874 with wheat bran and oat meal.
B 4526	Ful-O-Pop Dry Mash	Escanaba	9.9	20.2	5.5	8.2	4.60	Same as B 3784 with oat meal.
	Average		9.5	20.2	5.7	8.7		Same as B 3784 with wheat bran and oat meal.
B 4080	Ful-O-Pop Scratch Grains	Caro	11.6	9.8	2.3	3.1	5.00	Wheat, corn, kafir, milo, buckwheat, barley, sunflower.
B 4525	Ful-O-Pop Scratch Grains	Escanaba	13.2	10.7	2.9	2.9	4.60	Same as B 4080 without kafir.
	Average		12.4	10.3	2.6	3.0		
B 4082	Pansy Scratch Grains no grit	Caro	11.9	9.8	2.5	3.0	4.50	Wheat, oats, corn, kafir, milo, buckwheat, barley, sunflower.
B 4211	Pansy Scratch Grains no grit	Niles	11.5	10.6	2.8	3.5	1.00	Same as B 4082.
	Average		11.7	10.2	2.8	3.3		
B 4983	Pansy Scratch Grains with grit	Jackson	10.9	9.4	2.5	3.0	3.40	Same as B 4082 with grit.
B 4504	Quaker Scratch Grains no grit	Iron River	12.1	10.6	2.7	3.0	4.50	Wheat, cracked corn, kafir, milo, buckwheat, barley, sunflower.
B 4520	Quaker Scratch Grains no grit	Escanaba	12.6	10.0	2.6	2.7	3.50	Same as B 4504.
	Average		12.4	10.3	3.7	2.9		

B 4546	Schumacher Little Chick Feed no grit.....	G.* F.*	10.0 12.4	2.5 5.5	3.1 3.1	4.25	Wheat, oat meal, cracked corn, kafir, milo, wild buckwheat millet, weed seeds, charcoal.
B 4500	Schumacher Little Chick Feed with grit.....	G.* F.*	10.0 12.2	2.5 2.8	3.0 3.0	3.65	Same as B 4546 with grit.
B 3779	Schumacher Scratch Grains.....	G.* F.*	10.0 11.3	2.5 3.1	2.8 2.8	3.50	Wheat, cracked corn, kafir, milo, buckwheat, barley, sunflower.
B 4542	Schumacher Scratch Grains.....	G.* F.*	10.0 11.1	2.5 3.4	2.5 2.5	4.50	Same as B 3779 with oil cake.
B 4606	Schumacher Scratch Grains.....	G.* F.*	10.0 12.0	2.5 2.6	2.8 2.8	3.45	Same as B 3779 with grit.
B 4699	Schumacher Scratch Grains.....	G.* F.*	10.0 12.6	2.5 2.6	2.6 2.6	1.00	Same as B 3779 with screenings.
	Rosch & Seeber Co., Marquette, Mich.						
B 4348	Roseco Scratch Feed.....	G.* F.*	11.8 12.2	2.9 2.5	2.7 3.0	3.70	Wheat, oats, corn, kafir, buckwheat, barley, oil cake, sunflower.
B 4372	Roseco Scratch Feed.....	G.* F.*	11.7 10.1	3.0 3.0	2.8 2.8	3.20	Wheat, oats, corn, kafir, buckwheat, barley, grit.
	Rosenbaum Brothers, Chicago, Ill.						
B 4776	Rosebro Scratch Feed no grit.....	G.* F.*	12.0 12.4	2.9 3.3	2.9 3.2	1.20	Wheat, oats, cracked corn, kafir, buckwheat, barley, sunflower.
B 4631	Vitality Chick Mash with Milk Albumen.....	G.* F.*	11.5 14.1	3.8 3.8	6.8 6.8	3.85	Linsed meal, bone meal, alfalfa meal, corn feed meal, ground oats and barley, wheat flour middlings, milk albumen, calcium carbonate.
B 4632	Vitality Chick Mash with Milk Albumen.....	G.* F.*	12.2 14.1	4.1 4.1	6.3 6.3	3.85	Same as B 4631.
	Rosendall Bros., Grand Rapids, Mich.						
B 4646	Vitality Fattening Mash with Milk Albumen.....	G.* F.*	12.4 10.2	3.0 3.0	7.0 6.6		Alfalfa meal, wheat middlings, red dog flour, oat flour, corn, feed, meal, barley flour, milk albumen.
B 4773	Vitality Growing Scratch no grit.....	G.* F.*	11.6 11.1	3.2 2.5	2.5 2.5	4.35	Wheat, oats, cracked corn, kafir, barley, millet.
B 4634	Vitality Scratch Feed with grit.....	G.* F.*	12.9 10.5	3.0 3.0	3.8 3.8	3.90	Wheat, oats, cracked corn, kafir, buckwheat, barley, standard grit, shell.
B 4645	Will-Pay Chick Scratch no grit.....	G.* F.*	11.5 10.0	3.3 2.5	2.1 2.1		Cracked wheat, cracked corn, kafir, millet.
B 4775	Will-Pay Scratch Feed no grit.....	G.* F.*	11.9 10.4	3.0 3.0	3.1 3.1	4.10	Wheat, oats, cracked corn, kafir, barley, stuff-wor.
B 4771	Will-Pay Scratch Feed with grit and shell.....	G.* F.*	11.5 10.3	3.0 3.0	2.7 2.7	1.00	Same as B 4775 with grit and shell.
	Rosendall Bros., Grand Rapids, Mich.						
B 4296	Rosendall's Special Egg Mash.....	G.* F.*	22.0 23.2	5.0 5.3	5.0 6.3	3.75	Linsed meal, meat scraps, alfalfa meal, wheat bran and middlings corn meal.
B 1448	Ryde & Co., Chicago, Ill. Ryde's Milk Mash.....	G.* F.*	20.0 20.1	5.0 5.0	2.0 11.5	5.00	Cottonseed meal, hominy feed, breast bean meal, ground barleys, crushed meal, blood flour, wheat flour, wheat middlings, dried milk, oat meal, corn meal, footmugreek, anise, salt.

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUTTS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Saginaw Milling Co., Saginaw, Mich.								
B 4173	Red Hen Chick Starter.	Fenton	{ G.* 13.0	{ 11.0	{ 2.0	{ 3.0	{ 84.75	Peas, wheat, corn, kafir, millet.
B 1869	Red Hen Chick Starter.	Seottville.	{ F.* 13.1	{ 10.5	{ 1.9	{ 1.7	{ 4.50	Same as B 4173.
		Average.....	13.1	11.0	2.3	1.8	.....	Linsed meal, meat scraps, alfalfa meal, wheat bran and middlings, corn meal.
B 4027	Red Hen Mash.	Saginaw	{ G.* 9.8	{ 10.0	{ 3.5	{ 7.2	{ 3.30	Wheat, oats, corn, kafir, buckwheat, barley, sunflower.
B 3723	Red Hen Scratch Feed.	Owosso	{ F.* 12.4	{ 9.3	{ 3.0	{ 2.8	{ 3.50	Same as B 3723.
B 4036	Red Hen Scratch Feed.	Saginaw	{ F.* 11.8	{ 10.4	{ 3.0	{ 3.0	{ 3.50	Same as B 3723.
B 4068	Red Hen Scratch Feed.	Bay City	{ F.* 12.6	{ 10.1	{ 2.9	{ 3.7	.....	Same as B 3723 with beans.
B 4150	Red Hen Scratch Feed.	Millington	{ F.* 12.7	{ 10.5	{ 3.2	{ 3.2	{ 3.80	Same as B 3723.
B 4483	Red Hen Scratch Feed.	Mt. Morris	{ F.* 14.3	{ 9.3	{ 3.2	{ 2.9	{ 3.75	Same as B 3723.
B 4870	Red Hen Scratch Feed.	Seottville.	{ F.* 12.3	{ 10.4	{ 3.2	{ 3.5	{ 4.50	Same as B 3723.
B 4951	Red Hen Scratch Feed.	Lapeer	{ F.* 12.0	{ 10.0	{ 3.1	{ 3.3	{ 3.50	Same as B 3723.
		Average.....	12.5	10.1	3.0	3.3	.....	Wheat, oats, corn, kafir, buckwheat, barley, wheat screenings.
B 4027	Wolverine Scratch Feed.	Saginaw	{ G.* 11.9	{ 9.4	{ 2.5	{ 3.0	{ 3.35	Same as B 4037.
B 4018	Wolverine Scratch Feed.	Saginaw	{ F.* 11.5	{ 10.2	{ 3.6	{ 4.2	{ 4.00	Meat scraps, alfalfa meal, wheat bran and middlings, corn meal, corn bran, screenings.
		Average.....	11.7	10.5	3.5	4.0	.....	Peas, wheat, kafir, buckwheat.
Scheuren & Mok, Detroit, Mich.								
B 4726	Eagle Mash.	Detroit	{ G.* 8.7	{ 15.5	{ 4.5	{ 9.5	{ 2.85	Peas, wheat, kafir, buckwheat.
B 4725	Eagle Pigeon Feed.	Detroit	{ G.* 11.1	{ 14.1	{ 2.6	{ 3.4	{ 4.45	Oats, cracked corn, kafir, barley, sunflower.
B 3395	Eagle Scratch Feed.	Detroit (1918)	{ F.* 11.9	{ 11.0	{ 3.0	{ 3.3	{ 3.90	Same as B 3395, with wheat, without sunflower.
B 3319	Eagle Scratch Feed.	Detroit	{ F.* 11.4	{ 10.1	{ 3.0	{ 2.8	{ 3.75	Same as B 3395 with wheat and buckwheat.
B 4970	Eagle Scratch Feed.	Mt. Clemens	{ F.* 11.7	{ 9.9	{ 3.0	{ 3.8	.....
		Average.....	11.7	10.3	3.0	3.3	.....	Wheat, corn, kafir, buckwheat, barley, sunflower, screenings.
B 4073	Eagle Scratch Feed.	Mt. Clemens (1919)	{ G.* 13.1	{ 10.7	{ 2.7	{ 3.8	{ 3.75	Meat scraps, alfalfa meal, wheat bran and middlings, corn meal.
B 3396	Meat Mash.	Detroit	{ F.* 9.5	{ 18.4	{ 4.1	{ 6.1	{ 3.00	Cracked corn and millet.
B 3397	Pride Chick Feed.	Detroit	{ F.* 9.9	{ 9.8	{ 3.9	{ 3.5	{ 4.00	

B 1441	Schoell & Rath, Monroe, Mich.	Waterloo Scratch Feed.....	{ G.* F.*	{ 10.0 13.9	{ 2.5 2.7	{ 3.0 3.5	Wheat, oats, corn, buckwheat, barley.
B 1724	The Sheets Elevator Co., Cleveland, Ohio.	Cookley's Buttermilk Starting Feed.....	{ G.* F.*	{ 12.0 14.1	{ 3.0 3.5	{ 4.0 7.6	Bone, wheat, wheat bran and middlings, hulled oats, corn feed meal, dried buttermilk, iron sulfate, goulard, mustard seed.
B 1566	F. J. Smith, Pickford, Mich.	Pickford Mixed Grain.....	{ G.* F.*	{ 12.1 11.9	{ 2.2 2.7	{ 4.9 3.6	Pearl oats, corn, barley, grain screenings.
B 1619	Standard Grocer & Milling Co., Holland, Mich.	Olympia Chick Feed.....	{ G.* F.*	{ 8.0 10.7	{ 2.4 3.6	{ 4.0 3.4	Linsed cake, wheat, cracked corn, kafir, milo, millet.
B 3820		Standard Scratch Feed.....	{ G.* F.*	{ 9.4 11.8	{ 2.7 3.1	{ 4.0 2.6	Wheat, oats, cracked corn, kafir, buckwheat, barley, milo, linsed cake, grit.
B 4069	Wm. M. Stuck, Mt. Clemens, Mich.	Wm. M. Stuck Poultry Feed.....	{ G.* F.*	{ 8.5 11.4	{ 3.2 2.5	{ 3.1 3.8	Wheat, corn, kafir, buckwheat, barley, sunflower.
B 4641	Sturgis & Sons, Fowler, Mich.	Golden Bantam Chick Feed.....	{ G.* F.*	{ 10.0 11.9	{ 2.5 2.7	{ 3.0 2.1	Wheat, oats, corn, kafir, barley, rye.
B 4642		Golden Bantam Scratch Feed.....	{ G.* F.*	{ 10.0 10.5	{ 2.5 3.1	{ 3.0 3.5	Wheat, oats, corn, kafir, buckwheat, barley, sunflower.
B 4443	Toledo Grain & Milling Co., Toledo, Ohio.	Camp's Red Ball Chick Feed.....	{ G.* F.*	{ 10.0 12.2	{ 2.5 2.8	{ 3.0 2.1	Wheat, oat meal, corn, kafir, millet.
B 4448		Camp's Red Ball Scratch Feed.....	{ G.* F.*	{ 10.0 12.1	{ 2.5 3.2	{ 3.0 3.2	Wheat, oats, corn, kafir, milo, buckwheat, barley, sunflower.
B 3858	Valley City Milling Co., Grand Rapids, Mich.	Rowena Chick Feed.....	{ G.* F.*	{ 10.0 9.8	{ 2.5 3.1	{ 3.0 2.2	Wheat, corn, kafir, millet, grit.
B 3859		Rowena Egg Mash.....	{ G.* F.*	{ 15.0 15.2	{ 3.0 3.5	{ 10.0 9.9	Linsed meal, alfalfa meal, wheat bran and middlings, meat scraps, corn bran, corn feed meal, salt.
B 4645	The Walcott Grain Co., Saginaw, Mich.	Fortune Scratch Feed.....	{ G.* F.*	{ 10.1 10.7	{ 2.0 3.1	{ 4.2 3.8	Wheat, oats, corn, kafir, barley, wild buckwheat, sunflower.
B 4621	Watson-Higgins Milling Co., Grand Rapids, Mich.	Perfection Chick Feed.....	{ G.* F.*	{ 10.0 13.3	{ 2.5 3.6	{ 3.0 3.0	Oats, corn, kafir, millet, weed seeds.
B 4625		Perfection Chick Feed.....	{ G.* F.*	{ 12.8 13.4	{ 9.9 8.3	{ 2.9 3.5	Wheat, oats, corn, kafir, wild buckwheat, millet.
B 4635		Perfection Chick Feed.....	{ G.* F.*	{ 13.4 13.2	{ 8.3 9.7	{ 2.6 3.3	Oats, corn, milo, buckwheat.
		Average.....		13.2	9.7	3.3	2.5

Abbreviations for Guaranteed and Fomd.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.	Principal ingredients identified.
Watson-Higgins Milling Co., Grand Rapids, Mich. (Continued.)								
B 3200	Perfection Scratch Feed	(1918) G. ⁺	10.0	10.0	2.5	3.0	53 15	Wheat, oats, corn, kafir, buckwheat, barley, sunflower, grit.
B 4271	Perfection Scratch Feed	(F. ⁺)	11.7	10.7	2.6	3.9	3 85	Same as B 3200 without wheat and sunflower.
B 4292	Perfection Scratch Feed	Cadillac Grandville	12.5 10.3 12.4	10.3 13.0	3.1 2.9	1.2 3.5		Same as B 3200 without sunflower.
	Average		12.2	11.3	2.9	3.9		
E. L. Wellman Co., Grand Rapids, Mich.								
B 1496	Qualified Chick Feed with grit.	(G. ⁺)	10.0	10.0	2.5	3.0	3 25	Wheat, corn, kafir, wild buckwheat, millet, weed seeds, grit.
B 3768	Qualified Poultry Feed	(F. ⁺)	11.0	11.0	2.8	3.2		Wheat, oats, cracked corn, kafir, milo, buckwheat, barley, flower.
B 3918	Qualified Poultry Feed	(F. ⁺)	12.0	10.4	2.8	3.5	3 50	Same as B 3768.
B 4061	Qualified Poultry Feed	Cassiova	11.7	10.0	3.1	3.1	1 00	Same as B 3768.
B 4389	Qualified Poultry Feed	Bay City	10.7	10.0	2.6	3.0	3 85	Same as B 3768.
B 4918	Qualified Poultry Feed	East Jordan	13.0	10.6	2.2	2.4	3 50	Same as B 3768.
	Average		11.1	10.7	2.4	3.5	1 00	Same as B 3768.
B 4081	Qualified Poultry Feed with grit	(G. ⁺)	11.8	10.3	2.6	3.1		Wheat, oats, kafir, milo, wild buckwheat, barley, wheat, sorghum, grit.
	Pigeon	(F. ⁺)	10.0	9.8	2.5	3.8	1 00	
B 4099	Wenonah Flouring Mills, Bay City, Mich.	Bay City.						
	Wenonah Chicken Feed	(G. ⁺)	11.8	9.7	2.7	2.3	3 35	Beans, wheat, oats, corn, buckwheat, barley.
C. C. Wright, Owosso, Mich.								
B 4746	Oxidant Chick Feed	(G. ⁺)	10.0	10.0	2.5	3.0		Wheat, oats, cracked corn, kafir, milo, barley.
B 3721	Wright's Mixture	(1918) (F. ⁺)	12.5	10.9	2.5	2.1	3 65	Wheat, oats, corn, kafir, sunflower.
B 4747	Wright's Mixture	Owosso	12.0	11.3	3.0	3.5	3 50	Salvage wheat, oats, cracked corn, kafir, buckwheat, barley, flower.
	Average	(1919) (F. ⁺)	12.1	10.5	2.6	3.6	3 60	
Young-Randolph Seed Co., Owosso, Mich.								
B 4782	Chick Feed	(G. ⁺)	10.0	10.0	3.0	2.5	3 90	Cracked corn, barley, millet.
B 4781	Scratch Feed	(F. ⁺)	10.7	11.1	3.9	2.6	3 85	Oats, cracked corn, buckwheat, barley, sunflower.

CORN AND OAT FEEDS.

J. J. Budenoch Co., Chicago, Ill.

B 35140 XXX B. & O. Chop Feed

Ground barley, oat middlings, ground oat feed, salt.

Berk Cereal Co., Detroit, Mich.

B 35146 Royal Chop Feed.

Ground corn, oat meal mill by-products.

B 35149 Royal Chop Feed.

Same as B 35146.

B 35150 Royal Chop Feed.

Same as B 35146.

B 35156 Royal Chop Feed.

Same as B 35146.

B 35151 Royal Chop Feed.

Same as B 35146.

B 35152 Royal Chop Feed.

Same as B 35146.

B 35158 Royal Chop Feed.

Same as B 35146.

B 35159 Royal Chop Feed.

Same as B 35146.

B 35165 Royal Chop Feed.

Same as B 35146.

B 35168 Royal Chop Feed.

Same as B 35146.

Commercial Milling Co., Detroit, Mich.

B 35322 Honkel's Chop Feed

Oats, corn feed meal, rye middlings, oat meal mill by-products.

B 35325 Honkel's Chop Feed

Same as B 35322.

B 35326 Honkel's Chop Feed

Same as B 35322.

B 35329 Honkel's Chop Feed

Same as B 35322.

B 35330 Honkel's Chop Feed

Same as B 35322.

B 35331 Honkel's Chop Feed

Same as B 35322.

B 35332 Honkel's Chop Feed

Same as B 35322.

B 35333 Honkel's Chop Feed

Same as B 35322.

B 35334 Honkel's Chop Feed

Same as B 35322.

B 35335 Honkel's Chop Feed

Same as B 35322.

B 35336 Honkel's Chop Feed

Same as B 35322.

B 35337 Honkel's Chop Feed

Same as B 35322.

B 35338 Honkel's Chop Feed

Same as B 35322.

B 35339 Honkel's Chop Feed

Same as B 35322.

B 35340 Honkel's Chop Feed

Same as B 35322.

B 35341 Honkel's Chop Feed

Same as B 35322.

B 35342 Honkel's Chop Feed

Same as B 35322.

B 35343 Honkel's Chop Feed

Same as B 35322.

B 35344 Honkel's Chop Feed

Same as B 35322.

B 35345 Honkel's Chop Feed

Same as B 35322.

B 35346 Honkel's Chop Feed

Same as B 35322.

B 35347 Honkel's Chop Feed

Same as B 35322.

B 35348 Honkel's Chop Feed

Same as B 35322.

B 35349 Honkel's Chop Feed

Same as B 35322.

B 35350 Honkel's Chop Feed

Same as B 35322.

B 35351 Honkel's Chop Feed

Same as B 35322.

B 35352 Honkel's Chop Feed

Same as B 35322.

B 35353 Honkel's Chop Feed

Same as B 35322.

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ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	(Ruble fat.	(Ruble fiber.	Price per ton or cwt.	Principal ingredients identified.
B 3509	David Stott Flour Mills, Detroit, Mich. Stott's Winner Feed.....	{ G.* Detroit..... { F.*	10.0 10.7	10.0 8.5	5.0 3.6	10.0 9.1	\$15.50	Oat meal mill by-products, corn feed meal.
B 4312	Thunder Bay Milling Co., Alpena, Mich. Bradford's Chop.....	{ G.* Alpena..... { F.*	8.1 11.3	8.1 6.3	2.2 2.7	10.6 13.4	59.00	Oat hulls, corn flour, cracked corn.

*Abbreviations for Guaranteed and Found

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
WHEAT BRAN.							
Baldwin Flour Mills, Minneapolis, Minn.							
B 4371	Baldwin's Wheat Bran with not exceeding mill run ground screenings.....	Houghton.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 10.0	14.5 12.9	4.0 3.5	12.0 11.9	851.00
Big Diamond Mills Co., Minneapolis, Minn.							
B 4108	Big Diamond Wheat Bran with ground screenings not exceeding mill run.....	Carsonville.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 10.5	13.0 13.3	4.0 3.0	12.0 12.1	2.60
B 4133	Big Diamond Wheat Bran with ground screenings not exceeding mill run.....	Crowell.....	11.6	13.9	5.3	11.5	2.25
B 4310	Big Diamond Wheat Bran with ground screenings not exceeding mill run.....	Alpena.....	10.1	14.4	5.9	12.5	52.00
		Average.....	10.7	13.9	5.4	12.1	
J. P. Burroughs & Son, Flint, Mich.							
B 4470	Choice Winter Wheat Bran with ground screenings not exceeding mill run.....	Flint.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 10.4	12.5 15.3	3.0 4.3	10.5 9.2	
B 4474	Choice Winter Wheat Bran with ground screenings not exceeding mill run.....	Fenton.....	10.8	14.3	3.3	8.3	2.70
		Average.....	10.6	14.8	3.8	8.8	
Cannon Valley Milling Co., Minneapolis, Minn.							
B 3975	C. V. Wheat Bran with ground screenings not exceeding mill run.....	Reed City.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 9.8	15.0 15.1	4.0 6.1	14.0 10.6	58.00
B 4488	C. V. Wheat Bran with ground screenings not exceeding mill run.....	Chesaning.....	11.4	14.9	6.1	10.2	
		Average.....	10.6	15.0	6.1	10.4	
The Century Milling Co., Minneapolis, Minn.							
B 4241	Jersey Wheat Bran with ground screenings not exceeding mill run.....	Munising.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 9.8	13.0 15.2	4.0 5.1	13.0 11.1	43.00
The Cereal Mills Co., Wausau, Wis.							
B 4510	Wheat Bran with ground screenings not exceeding mill run.....	Carney.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 10.3	14.0 15.3	4.3 4.4	11.0 10.5	2.50
C. S. Christensen Co., Madelia, Minn.							
B 4471	Wheat Bran with ground screenings.....	Flushing.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 10.5	14.6 14.3	4.4 4.8	12.3 11.8	2.65
Claro Milling Co., Waseca, Minn.							
B 3475	Claro Wheat Bran with ground screenings not exceeding mill run.....	Grand Rapids.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 11.0	14.0 14.8	3.0 5.1	12.0 12.1	38.00
Commander Mills Co., Minneapolis, Minn.							
B 4279	Commander Wheat Bran with ground screenings not exceeding mill run.....	Galesburg.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 11.2	13.0 11.9	4.0 5.1	12.0 10.5	54.00
B 4954	Commander Wheat Bran with ground screenings not exceeding mill run.....	Inlay City.....	9.5	14.4	4.6	11.7	2.30
		Average.....	10.4	14.7	4.9	11.1	
Wm. A. Coombs Milling Co., Coldwater, Mich.							
B 3946	Wheat Bran with ground screenings not exceeding mill run.....	Kalamazoo.....	$\left\{ \begin{array}{l} G.* \\ F.* \end{array} \right.$ 10.2	14.0 14.8	3.0 4.3	9.0 9.3	50.00
B 4016	Wheat Bran with ground screenings not exceeding mill run.....	Coldwater.....	10.3	14.1	4.4	9.2	50.00
B 4151	Wheat Bran with ground screenings not exceeding mill run.....	Vassar.....	10.6	14.3	4.2	9.1	2.30
B 4151	Wheat Bran with ground screenings not exceeding mill run.....	Reading.....	9.6	15.4	3.7	8.5	2.45

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Win. A. Coombs Milling Co., Coldwater, Mich.—Continued.							
B 4182	Wheat Bran with ground screenings not exceeding mill run	Quincy	10.7	15.6	4.0	9.5	82.75
B 4185	Wheat Bran with ground screenings not exceeding mill run	Hudson	11.4	14.3	4.3	9.9	2.60
B 4451	Wheat Bran with ground screenings not exceeding mill run	Quincy	10.5	15.4	4.6	9.1	2.75
B 4452	Wheat Bran with ground screenings not exceeding mill run	Hudson	10.7	15.0	4.6	9.2	.....
B 4500	Wheat Bran with ground screenings not exceeding mill run	Ypsilanti	10.8	14.8	5.0	9.6	2.70
B 4745	Wheat Bran with ground screenings not exceeding mill run	Bronson	10.5	14.5	5.7	10.9	2.50
B 4908	Wheat Bran with ground screenings not exceeding mill run	Denton	10.8	14.6	4.7	9.0	2.60
		Average	10.6	14.8	4.5	9.1	.....
Crescent Milling Co., Minneapolis, Minn.							
B 3786	Crescent Wheat Bran with ground screenings not exceeding mill run	South Haven	(G.* F.*	14.2 13.7	3.8 5.0	12.0 9.9	50.00
DeRoo & Company, Flint, Mich.							
B 4467	Wheat Bran with ground screenings not exceeding mill run	Flint	(G.* F.*	13.0 10.6	3.0 15.2	10.0 4.3	46.50
B 4185	Wheat Bran with ground screenings not exceeding mill run	Clio	11.4	15.8	4.9	9.1	55.00
		Average	11.0	15.5	4.6	9.3	.....
Duluth Universal Milling Co., Duluth, Minn.							
B 3503	Wheat Bran with ground screenings not exceeding mill run	Detroit	(G.* F.*	13.8 11.3	4.1 16.1	12.7 10.3	33.60
B 4337	Wheat Bran with ground screenings not exceeding mill run	Newberry	10.6	16.3	5.5	10.6	2.25
B 4715	Wheat Bran with ground screenings not exceeding mill run	Royal Oak	9.6	15.9	4.9	10.8	2.65
B 4968	Wheat Bran with ground screenings not exceeding mill run	Mt. Clemens	10.1	16.4	5.5	10.7	2.50
		Average	10.4	16.2	5.4	10.6	.....
Eagle Roller Mill Co., New Ulm, Minn.							
B 3714	Wheat Bran with ground screenings	Owosso	(G.* F.*	14.0 10.2	3.4 14.1	12.0 4.9	40.00
B 3747	Wheat Bran with ground screenings	Perry	11.1	13.5	5.1	10.7	43.00
B 4109	Wheat Bran with ground screenings	Carsonville	10.1	11.6	5.1	11.7	2.60
B 4355	Wheat Bran with ground screenings	Negaunee	10.2	13.9	5.3	10.9	2.75
B 4537	Wheat Bran with ground screenings	Manistique	11.5	15.1	5.6	10.3	51.00
		Average	10.6	14.3	5.2	10.9	.....
B. A. Eckhart Milling Co., Chicago, Ill.							
B 3595	Wheat Bran and Screenings	Albion	(G.* F.*	14.0 10.0	4.0 15.8	11.0 4.5	45.00
B 3600	Wheat Bran and Screenings	Albion	10.4	17.3	4.5	9.6	2.25
B 1707	Wheat Bran and Screenings	Oxford	9.9	15.4	4.5	9.4	2.50
		Average	10.1	16.2	4.5	9.7	.....
Empire Milling Co., Minneapolis, Minn.							
B 1062	Empire Bran with ground screenings	Bay City	(G.* F.*	12.0 10.2	4.0 14.8	12.0 4.7	2.70
B 4106	Empire Bran with ground screenings	Yale	11.4	13.9	5.1	10.9	40.50
B 4129	Empire Bran with ground screenings	Croswell	11.2	14.4	5.5	11.5	50.00
B 4158	Empire Bran with ground screenings	Vassar	11.9	14.2	4.6	10.5	2.50
B 4501	Empire Bran with ground screenings	Stambaugh	10.2	14.6	5.0	10.5	2.75
		Average	11.0	14.1	5.0	11.0	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Everett Aughenbaugh Co., Waseca, Minn.							
B 4156	Eaco Wheat Bran with ground screenings	(G.* Vassar.....	12 5	14 0	5 4	12 9	82 50
B 4407	Eaco Wheat Bran with ground screenings.....	(F.* Jackson.....	11 6	15 0	5 5	10 4	2 50
	Average		12 1	14 8	5 5	10 0	..
Gooch Milling & Elevator Co., Lincoln, Neb.							
B 4225	Wheat Bran and ground screenings.....	(G.* Benton Harbor ..	15 5	18 1	2 5	10 0	55 00
		(F.*	9 9		4 1	10 0	
Hankey Milling Co., Petoskey, Mich.							
B 4819	Bran with mill run screenings.....	(G.* Mancelona.....	13 5	15 0	3 7	9 5	2 65
		(F.*	11 1		5 1	9 1	
Hannah & Lay Co., Traverse City, Mich.							
B 4833	Wheat Bran with ground screenings not exceeding mill run	(G.* Traverse City....	15 0	15 1	5 0	11 6	18 00
		(F.*	10 4		5 0	11 7	
Harris Milling Co., Mt. Pleasant, Mich.							
B 1852	Bran with ground screenings	(G.* Frankfort.....	13 0	13 9	3 0	13 0	2 50
B 4863	Bran with ground screenings.....	(F.* Manistee.....	10 9	13 5	3 8	11 1	2 75
			11 0		4 1	11 3	
	Average		11 0	13 7	4 0	11 2	..
W. J. Jennison Co., Minneapolis, Minn.							
B 3400	Wheat Bran with ground screenings not exceeding mill run	(1918) (G.* Detroit.....	14 0	14 5	4 0	14 0	33 60
B 3956	Wheat Bran with ground screenings not exceeding mill run	(F.* Edmore.....	10 7	14 1	4 8	10 3	55 00
B 4105	Wheat Bran with ground screenings not exceeding mill run	North Branch.....	9 7	14 1	5 6	10 9	2 50
			11 8	13 8	5 3	11 2	
	Average		10 7	14 1	5 2	10 8	..
B 4065	Wheat Bran with ground screenings not exceeding mill run	(1919) (G.* Bay City.....	12 0	11 2	4 0	12 0	2 40
B 4161	Wheat Bran with ground screenings not exceeding mill run	(F.* Millington.....	9 4	11 3	5 3	10 4	2 15
B 4301	Wheat Bran with ground screenings not exceeding mill run	Gladwin.....	10 9	11 3	4 6	11 7	53 00
B 4305	Wheat Bran with ground screenings not exceeding mill run	Pinconning.....	10 4	14 1	5 8	11 9	54 00
B 4885	Wheat Bran with ground screenings not exceeding mill run	Clifford.....	10 1	15 0	5 3	11 2	2 75
			11 4	13 9	5 2	11 0	
	Average		10 4	14 3	5 2	11 2	..
The Kansas Flour Mills Co., Kansas City, Mo.							
B 4053	Wheat Bran and Wheat Screenings.....	(G.* Bay City.....	14 5	16 5	3 5	11 0	..
		(F.*	9 7		4 6	9 6	
The Kaw Milling Co., Topeka, Kansas.							
B 3185	Kaw Kaw Wheat Bran and screenings not to exceed 8%	(G.* Coopersville....	14 5	16 2	3 5	11 0	10 00
B 3485	Kaw Kaw Wheat Bran and screenings not to exceed 8%	(F.* Forest Grove.....	9 3	16 8	4 1	7 6	42 00
			10 9	16 5	3 8	8 7	..
	Average		10 2	16 5	4 0	8 2	..
B 3427	Kaw Kaw Wheat Bran and scourings.....	(G.* Nunica.....	14 5	18 7	3 5	8 5	39 50
B 4288	Kaw Kaw Wheat Bran and scourings.....	(F.* Coopersville.....	10 9	18 3	4 1	8 6	50 00
			9 4		4 2	9 1	
	Average		10 2	18 5	4 2	8 9	..

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
The Larabee Flour Mills Corp., Kansas City, Mo.							
B 3971	Wheat Bran with mill run screenings not to exceed 8%	Clare..... { G.* F.*	9.2	15.0 16.3	3.5 4.3	10.5 10.8	..... \$53.09
B 4952	Wheat Bran with mill run screenings not to exceed 8%	Capac.....	9.6	16.9	3.9	10.4	2.30
B 4956	Wheat Bran with mill run screenings not to exceed 8%	Port Huron.....	9.5	17.8	4.3	10.3	2.75
		Average.....	9.4	17.0	4.2	10.5	.....
Lindsborg Milling & Elevator Co., Lindsborg, Kansas.							
B 3826	Wheat Bran and screenings.....	Holland..... { G.* F.*	9.8	14.5 16.9	3.5 4.4	11.0 10.6	..... 36.00
B 3850	Wheat Bran and screenings.....	Sparta.....	11.0	17.3	4.7	7.7	42.00
B 4980	Wheat Bran and screenings.....	Mt. Clemens.....	9.0	16.5	4.4	10.8	2.50
		Average.....	9.9	16.9	4.5	9.7	.....
Montana Flour Mills Co., Lewiston, Montana.							
B 3193	Monteo Wheat Bran with ground screenings not exceeding mill run	Vriesland..... { G.* F.*	12.0	13.8 16.9	3.7 4.1	13.9 9.8	..... 42.00
B 3769	Monteo Wheat Bran with ground screenings not exceeding mill run	South Haven.....	11.5	16.9	4.9	10.0	49.06
B 3893	Monteo Wheat Bran with ground screenings not exceeding mill run	Muskegon.....	11.3	16.3	4.8	10.0	38.00
B 4219	Monteo Wheat Bran with ground screenings not exceeding mill run	Big Rapids.....	11.4	16.3	4.8	10.2	55.00
		Average.....	11.6	16.6	4.7	10.0	.....
New Prague Flouring Mills Co., New Prague, Minn.							
B 4070	Seal of Minnesota Wheat Bran with ground screenings not exceeding mill run	Caro..... { G.* F.*	10.3	13.3 14.5	3.0 5.0	12.0 10.4	..... 2.69
B 4076	Seal of Minnesota Wheat Bran with ground screenings not exceeding mill run	Caro.....	10.3	11.6	5.2	9.8	2.35
B 4090	Seal of Minnesota Wheat Bran with ground screenings not exceeding mill run	Bad Axe.....	9.3	11.2	5.4	10.7	55.00
B 4141	Seal of Minnesota Wheat Bran with ground screenings not exceeding mill run	Marlette.....	11.0	11.5	5.3	10.5	2.50
B 4529	Seal of Minnesota Wheat Bran with ground screenings not exceeding mill run	Bark River.....	10.2	14.2	5.3	10.7	2.50
		Average.....	10.2	11.1	5.2	10.4	.....
New Richmond Roller Mills Co., New Richmond, Wis.							
B 4335	Wheat Bran with ground screenings not to exceed mill run	Sault Ste. Marie..... { G.* F.*	10.5	13.0 14.4	3.2 4.5	12.0 10.1	..... 42.00
B 4340	Wheat Bran with ground screenings not to exceed mill run	Munising.....	9.5	14.6	5.7	9.4	43.00
		Average.....	10.0	14.5	5.1	9.8	.....
Northern Milling Co., Wausau, Wis.							
B 4563	Wheat Bran with ground screenings	Rock..... { G.* F.*	9.6	14.0 12.2	4.0 5.1	13.0 12.0	..... 2.75
Oriental Mills, Manitowoc, Wis.							
B 4871	Wheat Bran with ground screenings	Scottville..... { G.* F.*	10.7	15.0 13.0	4.0 4.2	11.0 9.0	..... 2.75
Pillsbury Flour Mills, Minneapolis, Minn.							
B 3576	Wheat Bran with ground screenings not exceeding mill run	Detroit..... { G.* F.*	10.3	13.0 15.1	4.0 4.8	13.0 11.0	.....
B 4150	Wheat Bran with ground screenings not exceeding mill run	Vassar.....	11.1	14.2	5.1	11.9	2.30
B 4371	Wheat Bran with ground screenings not exceeding mill run	Houghton.....	10.2	15.1	5.5	10.9	55.00
B 4470	Wheat Bran with ground screenings not exceeding mill run	Holy.....	9.7	16.6	3.7	12.2	2.95
		Average.....	10.4	15.3	4.8	11.5	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1917-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Red Star Milling Co., Wichita, Kansas.							
B 4127	Wheat Bran with screenings.....	Palms..... { G.* F.*	10.7	14.5 16.8	3.5 4.8	10.0 8.9	\$2.25
Red Wing Milling Co., Red Wing, Minn.							
B 4874	Bixota Wheat Bran and ground screenings.....	Ludington..... { G.* F.*	10.2	13.5 14.8	4.1 5.7	15.6 11.1	2.60
Sheffield King Milling Co., Minneapolis, Minn.							
B 3605	Fancy Brodflake.....	Marshall..... { G.* F.*	10.0	13.5 18.1	3.5 4.3	12.7 9.3	45.50
Stanard Tilton Milling Co., St. Louis, Mo.							
B 4101	Wheat Bran with ground screenings not exceeding mill run.....	Cass City..... { G.* F.*	11.3	14.5 18.1	4.0 4.6	9.5 9.7	40.00
Star & Crescent Milling Co., Chicago, Ill.							
B 3420	Star and Crescent Bran.....	Grand Rapids..... { G.* F.*	10.6	15.0 16.5	4.0 4.3	10.0 10.7	2.20
B 3450	Star and Crescent Bran.....	Zealand.....	11.2	13.8	5.0	12.1	38.00
B 3815	Star and Crescent Bran.....	Holland.....	10.2	14.0	5.1	11.5	37.10
B 3892	Star and Crescent Bran.....	Muskegon.....	10.7	15.8	3.6	9.6	39.00
B 4865	Star and Crescent Bran.....	Scottville.....	10.6	14.6	4.4	11.2	3.00
		Average.....	11.9	14.9	4.5	11.0	
David Stott Flour Mills, Detroit, Mich.							
B 3511	Spring Wheat Bran and Wheat Screenings.....	Detroit..... { G.* F.*	11.0	14.0 15.7	4.0 4.6	12.0 9.8	27.46
Valier & Spies Milling Co., St. Louis, Mo.							
B 4446	Valier's Wheat Bran with ground screenings.....	Trenton..... { G.* F.*	9.9	14.5 17.9	3.5 4.4	10.0 9.6	
B 4496	Valier's Wheat Bran with ground screenings.....	Ypsilanti.....	10.7	18.4	4.8	9.3	2.50
		Average.....	10.3	18.2	4.6	9.5	
Valley City Milling Co., Grand Rapids, Mich.							
B 3793	Rowena Wheat Bran with ground screenings not exceeding mill run.....	Hartford..... { G.* F.*	10.4	14.0 14.1	3.5 4.1	10.0 11.3	42.00
B 3862	Rowena Wheat Bran with ground screenings not exceeding mill run.....	Grand Rapids.....	10.8	14.1	4.2	10.6	37.10
B 3613	Rowena Wheat Bran with ground screenings not exceeding mill run.....	Marshall.....	10.7	14.6	3.8	11.5	41.00
B 3708	Rowena Wheat Bran with ground screenings not exceeding mill run.....	St. Johns.....	10.3	15.3	4.1	9.7	40.00
B 3773	Rowena Wheat Bran with ground screenings not exceeding mill run.....	South Haven.....	11.1	14.1	4.0	10.3	40.00
B 4207	Rowena Wheat Bran with ground screenings not exceeding mill run.....	Vicksburg.....	10.3	15.6	4.4	12.8	60.00
B 4812	Rowena Wheat Bran with ground screenings not exceeding mill run.....	Boyne City.....	10.2	15.1	4.0	10.2	45.00
		Average.....	10.5	14.7	4.1	10.9	
Voigt Milling Co., Grand Rapids, Mich.							
B 3175	Crescent Brand Bran with mill run screenings.....	Hudsonville..... { G.* F.*	10.0	14.0 15.6	4.0 3.6	11.0 9.1	38.00
B 3842	Crescent Brand Bran with mill run screenings.....	Wayland.....	10.8	14.4	3.7	8.0	2.25
B 3905	Crescent Brand Bran with mill run screenings.....	Hudsonville.....	10.4	15.8	3.7	9.1	38.00
B 3611	Crescent Brand Bran with mill run screenings.....	Grand Rapids.....	9.2	16.0	4.3	8.2	46.00
		Average.....	10.1	15.5	4.8	8.6	
Wagner White Co., Inc., Jackson, Mich.							
B 4422	Wheat Bran with screenings.....	Morenci..... { G.* F.*	10.0	14.5 17.0	3.5 4.0	10.0 10.1	2.70
B 4423	Wheat Bran with screenings.....	Morenci.....	10.1	20.3	3.9	9.9	53.00
		Average.....	10.1	18.7	4.0	10.0	

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Washburn-Crosby Co., Minneapolis, Minn.							
B 3383	Wheat Bran with ground screenings not exceeding mill run.....	Detroit..... (G.* F.*	11.3	13.0 11.8	4.0 5.1	13.0 11.4	\$52.00
B 3479	Wheat Bran with ground screenings not exceeding mill run.....	Comstock Park.....	10.6	15.6	4.1	16.5	35.80
B 3515	Wheat Bran with ground screenings not exceeding mill run.....	Detroit.....	9.5	11.1	5.6	10.8	41.00
B 3668	Wheat Bran with ground screenings not exceeding mill run.....	Lansing.....	9.6	14.8	4.8	11.6	.....
B 4367	Wheat Bran with ground screenings not exceeding mill run.....	Chassell.....	10.8	13.9	5.8	11.0	2.50
B 4883	Wheat Bran with ground screenings not exceeding mill run.....	Ludington.....	11.0	15.0	5.2	10.1	2.70
		Average.....	10.5	14.7	5.1	11.9	.....
Western Flour Mill Co., Davenport, Iowa.							
B 4136	Black Hawk Wheat Bran with ground screenings not exceeding mill run.....	Palms..... (G.* F.*	10.9	13.3 16.0	3.0 4.9	15.5 10.5	2.25
B 4803	Black Hawk Wheat Bran with ground screenings not exceeding mill run.....	Petoskey.....	10.1	15.6	4.8	11.3	2.80
		Average.....	10.5	15.8	4.9	10.9	.....
Willy & Company, Appleton, Wis.							
B 4505	Wheat Bran with ground screenings not exceeding mill run.....	Crystal Falls..... (G.* F.*	11.0	15.0 13.5	4.0 5.3	11.0 10.1	2.75
WHEAT MIDLINGS.							
Bladwin Flour Mills Co., Minneapolis, Minn.							
B 4400	Baldwin Wheat Flour Middlings with not exceeding mill run of ground screenings.....	Ironwood..... (G.* F.*	11.2	16.5 13.7	5.0 4.7	7.0 5.8	52.00
Bay State Milling Co., Winona, Minn.							
B 4046	Bay State Wheat Middlings and wheat screenings.....	Saginaw..... (G.* F.*	9.5	16.5 17.2	5.0 6.1	8.3 7.1	2.35
B 4327	Bay State Wheat Middlings and wheat screenings.....	Sault Ste. Marie.....	11.2	17.4	5.7	6.9	45.00
B 4527	Bay State Wheat Middlings and wheat screenings.....	Bark River.....	11.0	17.2	5.9	6.7	2.65
B 4536	Bay State Wheat Middlings and wheat screenings.....	Manistique.....	10.9	16.9	5.7	7.0	2.75
		Average.....	10.7	17.2	5.9	6.9	.....
Big Diamond Mills Co., Minneapolis, Minn.							
B 3965	Big Diamond Standard Middlings with ground screenings.....	Ithaca..... (G.* F.*	9.9	15.0 16.1	5.0 5.6	10.0 8.2	41.00
B 4311	Big Diamond Standard Middlings with ground screenings.....	Alpena.....	10.5	16.5	5.9	8.1	56.00
		Average.....	10.2	16.3	5.8	8.2	.....
The Century Milling Co., Minneapolis, Minn.							
B 4342	Poland Standard Middlings with ground screenings not exceeding mill run.....	Munising..... (G.* F.*	9.6	14.0 18.1	4.0 6.0	11.0 7.8	45.00
B 4555	Poland Standard Middlings with ground screenings not exceeding mill run.....	Nenominee.....	10.9	18.2	5.8	7.7	2.60
		Average.....	10.3	18.2	5.9	7.8	.....
Commander Mill Co., Minneapolis, Minn.							
B 4276	Commander Wheat Standard Middlings.....	Galesburg..... (G.* F.*	11.8	15.0 16.3	5.0 5.7	10.0 8.1	56.00
B 4404	Commander Wheat Standard Middlings.....	Toomuch.....	11.0	16.1	6.0	7.9	2.85
B 4953	Commander Wheat Standard Middlings.....	Inlay City.....	10.0	17.0	5.6	6.0	2.40
		Average.....	10.9	16.5	5.8	7.3	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Commercial Milling Co., Detroit, Mich.							
B 3335	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit..... { G.* F.*	13.5 11.3	4.5 17.8	4.5 4.9	10.0 7.6	\$10.00
B 3354	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	10.9	16.4	4.5	7.2	40.00
B 3374	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	11.6	17.0	4.3	6.5	37.60
B 3389	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	9.9	17.4	4.6	7.0	37.00
B 3507	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	11.2	16.6	4.5	6.6	.....
B 3527	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	11.3	17.9	4.8	7.5	37.00
B 3540	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	11.3	18.2	5.1	7.0	51.00
B 3550	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	11.7	18.1	4.3	7.0	54.00
B 3565	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	11.9	18.4	4.5	7.4	48.00
B 3569	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	8.8	16.9	4.6	6.7	44.00
B 3624	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	12.2	17.8	4.6	7.3	37.75
B 3651	Standard Wheat Middlings with ground screenings not exceeding mill run	Detroit.....	11.9	17.6	4.3	7.2	43.00
B 4587	Standard Wheat Middlings with ground screenings not exceeding mill run	Bellaire.....	11.9	16.6	4.5	7.1	2.70
B 4816	Standard Wheat Middlings with ground screenings not exceeding mill run	Boyne City.....	11.9	17.3	4.9	7.6	2.90
Consolidated Flour Mills Co., Hutchinson, Kansas							
	Average.....		11.3	17.4	4.6	7.1	.....
B 4478	Wheat Shorts and Screenings.....	Holly..... { G.* F.*	16.0 11.5	3.5 20.9	8.0 4.7	5.9	2.50
Wm. A. Coombs Milling Co., Coldwater, Mich.							
B 4017	Rob Roy Feed Wheat Middlings with ground screenings not exceeding mill run	Coldwater..... { G.* F.*	15.0 11.0	3.0 16.7	6.0 4.6	6.4	52.00
B 4180	Rob Roy Feed Wheat Middlings with ground screenings not exceeding mill run	Reading.....	11.1	16.1	4.6	7.6	2.75
B 4184	Rob Roy Feed Wheat Middlings with ground screenings not exceeding mill run	Hudson.....	11.3	17.6	4.5	6.8	3.00
B 4150	Rob Roy Feed Wheat Middlings with ground screenings not exceeding mill run	Quincy.....	10.8	16.8	4.8	7.6	3.00
B 4453	Rob Roy Feed Wheat Middlings with ground screenings not exceeding mill run	Hudson.....	11.3	18.0	4.5	6.5	.....
	Average.....		11.2	17.1	4.6	7.0	.....
Crescent Milling Co., Minneapolis, Minn.							
B 3787	Crescent Wheat Middlings with ground screenings not exceeding mill run	South Haven..... { G.* F.*	15.8 11.2	3.8 15.6	10.0 5.1	7.5	52.00
Duluth Superior Milling Co., Duluth, Minn.							
B 4389	Diamond S Standard Middlings with ground screenings.....	Ontonagon..... { G.* F.*	16.0 10.5	5.2 17.3	10.5 6.3	7.6	3.25
Duluth Universal Milling Co., Duluth, Minn.							
B 4336	Wheat Flour Middlings with ground screenings.....	Newberry..... { G.* F.*	16.8 11.0	5.0 17.9	5.6 6.1	6.5	2.50
Eagle Roller Mill Co., New Ulm, Minn.							
B 3713	Standard Middlings with ground screenings not exceeding mill run	Owosso..... { G.* F.*	14.0 10.9	4.0 15.8	11.0 5.0	8.7	37.00
B 4354	Standard Middlings with ground screenings not exceeding mill run	Negaunee.....	11.5	16.1	4.9	8.8	3.00
B 4538	Standard Middlings with ground screenings not exceeding mill run	Mauistique.....	11.8	16.4	5.3	7.7	50.00
	Average.....		11.4	16.1	5.1	8.4	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Empire Milling Co., Minneapolis, Minn.							
B 4107	Empire Wheat Standard Middlings with ground screenings not exceeding mill run	Yale. { G.* F.*	11.2	15.0 15.8	5.0 5.1	19.0 8.0	..... \$42.00
B 4130	Empire Wheat Standard Middlings with ground screenings not exceeding mill run	Croswell.	11.4	15.6	5.1	10.0	2.60
B 4366	Empire Wheat Standard Middlings with ground screenings not exceeding mill run	Chasell.	10.8	16.1	5.8	8.4	3.00
		Average.	11.1	15.8	5.3	8.8	.....
Gooch Milling Co., Lincoln, Neb.							
B 4226	Wheat Shorts with ground screenings	Benton Harbor. { G.* F.*	10.4	18.0 20.3	4.7 5.2	5.3 6.5	..... 60.00
Hannah & Lay Co., Traverse City, Mich.							
B 4839	Wheat Middlings with ground screenings not exceeding mill run	Traverse City. { G.* F.*	11.1	17.0 16.8	4.6 5.4	7.4 7.3	..... 50.00
Hubbard Milling Co., Mankato, Minn.							
B 4539	Standard Fine Middlings with ground screenings not exceeding mill run	Nadeau. { G.* F.*	11.0	15.0 17.1	5.0 5.4	11.0 8.1	..... 2.70
Ismert Hincke Milling Co., Kansas City, Mo.							
B 3429	ABC Whrat Middlings with mill run ground screenings	Grand Haven. { G.* F.*	11.3	16.0 19.6	3.5 4.5	6.5 6.9	..... 38.00
B 3904	ABC Wheat Middlings with mill run ground screenings	Muskegon Heights.	11.2	18.8	4.1	6.7	40.00
B 4429	ABC Wheat Middlings with mill run ground screenings	Blissfield.	10.6	19.8	4.5	6.4	.....
		Average.	11.0	19.4	4.4	6.7	.....
W. J. Jennison Co., Minneapolis, Minn.							
B 4104	Wheat Flour Middlings with ground screenings not exceeding mill run	North Branch. { G.* F.*	11.8	16.0 16.4	5.0 5.6	8.0 7.6	..... 2.75
B 4160	Wheat Flour Middlings with ground screenings not exceeding mill run	Millington.	11.3	16.9	5.2	6.8	2.65
B 4302	Wheat Flour Middlings with ground screenings not exceeding mill run	Gladwin.	10.9	16.7	6.0	7.7	58.00
B 4884	Wheat Flour Middlings with ground screenings not exceeding mill run	Clifford.	11.7	16.7	5.5	6.9	55.00
		Average.	11.4	16.7	5.6	7.3	.....
B 3501	Wheat Standard Middlings with ground screenings not exceeding mill run	Detroit. { G.* F.*	12.1	15.0 16.8	5.0 5.2	10.0 6.4	..... 37.50
B 3955	Wheat Standard Middlings with ground screenings not exceeding mill run	Edmore.	10.5	15.9	5.9	7.4	55.00
B 4066	Wheat Standard Middlings with ground screenings not exceeding mill run	Bay City.	10.6	16.3	5.9	7.0	2.50
		Average.	11.1	16.3	5.7	6.9	.....
The Kaw Milling Co., Topeka, Kansas.							
B 3426	Kaw Kaw Standard Shorts with ground screenings	Nunica. { G.* F.*	12.1	16.0 19.6	3.5 4.0	6.5 4.9	..... 41.50
Chas. A. Krause Milling Co., Milwaukee, Wis.							
B 4153	Badger Fancy Middlings with ground screenings and corn red dog flour	Vassar. { G.* F.*	10.4	12.0 12.6	4.0 5.9	7.0 3.3	..... 3.00
Larabee Flour Mills Corporation, Hutchinson, Kansas.							
B 4955	Standard Wheat Shorts with ground screenings	Port Huron. { G.* F.*	10.1	17.0 21.2	4.7 5.8	6.2 5.7	..... 2.75

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Marinette Flour Mill Co., Marinette, Wis.							
B 4507	Wheat Standard Middlings with ground screenings not exceeding mill run.....	Iron Mountain..... { G.* F.*	11.1	16.0	5.0	8.0	82.75
The Mennel Milling Co., Toledo, Ohio.							
B 3922	Mennel Middlings with ground screenings not exceeding mill run.....	Middleton..... { G.* F.*	10.0	15.0	4.0	6.5	...
Michigan Milling Co., Ann Arbor, Mich.							
B 4462	Minico Fancy Wheat Middlings with ground screenings.....	Durand..... { G.* F.*	10.7	14.1	4.6	5.7	50.00
Montana Flour Mills Co., Lewiston, Montana.							
B 3494	Montco Wheat Middlings with ground screenings not exceeding mill run.....	Vriesland..... { G.* F.*	11.7	15.7	4.7	9.0	...
B 3740	Montco Wheat Middlings with ground screenings not exceeding mill run.....	Mason.....	10.3	16.6	4.7	7.7	48.00
B 3770	Montco Wheat Middlings with ground screenings not exceeding mill run.....	South Haven.....	10.7	16.7	4.9	8.9	46.00
	Average.....		10.9	16.6	5.0	8.6	...
New Richmond Roller Mills Co., New Richmond, Wis.							
B 4339	Wheat Middlings with ground screenings not exceeding mill run.....	Munising..... { G.* F.*	9.5	15.0	3.5	9.0	45.00
B 4351	Wheat Middlings with ground screenings not exceeding mill run.....	Marquette.....	10.3	14.9	5.1	8.8	2.70
B 4519	Wheat Middlings with ground screenings not exceeding mill run.....	Escanaba.....	11.4	15.1	5.4	8.9	47.00
	Average.....		10.4	15.2	5.2	9.0	...
Northern Milling Co., Wausau, Wis.							
B 1562	Wheat Middlings with ground screenings.....	Rock..... { G.* F.*	9.6	15.0	4.0	8.0	2.75
The Northwestern Consolidated Milling Co., Minneapolis, Minn.							
B 3121	Wheat Flour Middlings with ground screenings not exceeding mill run.....	Grand Rapids... { G.* F.*	10.6	15.5	5.5	6.0	2.35
B 4330	Wheat Flour Middlings with ground screenings not exceeding mill run.....	Sault Ste. Marie.....	9.9	16.3	6.1	8.0	58.00
	Average.....		10.3	17.3	5.8	7.6	...
B 4524	Wheat Standard Middlings with ground screenings not exceeding mill run.....	Escanaba..... { G.* F.*	10.5	15.0	4.5	11.0	2.25
Northwestern Elevator & Mill Co., Toledo, Ohio.							
B 4124	Wheat Middlings with ground screenings.....	Morenci..... { G.* F.*	10.9	14.0	3.0	9.0	57.00
Omaha Flour Mills Co., Omaha, Nebraska.							
B 1074	Omaha Wheat Shorts and ground wheat screenings not exceeding 8%.....	Caro..... { G.* F.*	10.6	15.0	3.5	8.0	2.60
B 4571	Omaha Wheat Shorts and ground wheat screenings not exceeding 8%.....	Charlevoix.....	9.8	19.3	4.9	8.0	49.00
	Average.....		10.2	19.3	5.0	7.2	...
Pillsbury Flour Mills Co., Minneapolis, Minn.							
B 4370	Wheat A Middlings with ground screenings not exceeding mill run.....	Houghton..... { G.* F.*	10.3	15.0	4.0	8.0	61.50
B 3574	Wheat Standard B Middlings with ground screenings not exceeding mill run.....	Detroit..... { G.* F.*	10.8	13.0	4.0	11.0	43.00

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Pillsbury Flour Mills Co., Minneapolis, Minn. —Cont.							
B 4369	Wheat Standard B Middlings with ground screenings not exceeding mill run	Houghton	10.3	15.6	5.7	10.0	\$55.50
B 4533	Wheat Standard B Middlings with ground screenings not exceeding mill run	Wilson	10.5	11.6	4.9	9.5	3.00
B 4882	Wheat Standard B Middlings with ground screenings not exceeding mill run	Ludington	11.0	15.8	5.3	9.5	2.90
		Average	10.7	15.6	5.1	9.6	
Shane Bros. & Wilson Co., Minneapolis, Minn.							
B 4396	Snowball Wheat Flour Middlings with ground screenings	Ironwood	{ G.* F.* G.* F.*	16.5 17.1 15.3 16.9	5.5 5.6 6.4 5.2	6.0 7.1 10.5 7.7	2.70
B 3719	Wheat Standard Middlings with ground screenings	Owosso	11.5	16.9	5.2	7.7	38.00
B 4360	Wheat Standard Middlings with ground screenings	Negaunee	10.4	17.2	5.5	8.2	2.75
B 4576	Wheat Standard Middlings with ground screenings	Charlevoix	10.3	16.8	5.7	9.1	2.60
		Average	10.7	17.0	5.5	8.3	
The Southwestern Milling Co., Inc., Kansas City, Mo.							
B 4541	Red Turkey Wheat Brown Shorts and Wheat Scourings	Carney	{ G.* F.*	15.0 19.6	4.2 4.6	8.5 8.0	2.70
Stanard Tilton Milling Co., St. Louis, Mo.							
B 4100	Wheat Middlings with screenings not exceeding mill run	Cass City	{ G.* F.*	15.0 19.6	4.0 5.2	6.0 6.0	42.00
Star & Crescent Milling Co., Chicago, Ill.							
B 4862	Star Wheat Middlings with ground screenings not exceeding mill run	Manistee	{ G.* F.*	15.0 16.4	4.0 4.9	8.0 8.9	2.85
B 4866	Star Wheat Middlings with ground screenings not exceeding mill run	Scottville	11.3	17.2	5.0	7.6	3.00
		Average	11.2	16.8	5.0	8.3	
David Stott Flour Mills, Detroit, Mich.							
B 3373	Pennant Wheat Middlings and Wheat Screenings	Detroit	{ G.* F.*	15.5 16.3	5.0 4.0	7.0 5.7	34.66
B 3510	Pennant Wheat Middlings and Wheat Screenings	Detroit	11.0	16.9	4.3	7.1	29.46
B 3564	Pennant Wheat Middlings and Wheat Screenings	Detroit	11.9	17.4	4.6	6.2	48.00
B 3570	Pennant Wheat Middlings and Wheat Screenings	Detroit	11.1	17.2	4.4	6.2	44.00
B 3652	Pennant Wheat Middlings and Wheat Screenings	Detroit	11.8	16.1	4.2	6.6	2.25
B 4434	Pennant Wheat Middlings and Wheat Screenings	Adrian	10.1	17.6	4.5	7.1	59.00
B 4717	Pennant Wheat Middlings and Wheat Screenings	Royal Oak	9.9	17.6	4.9	6.7	2.70
		Average	11.0	17.0	4.4	6.5	
St. Paul Milling Co., St. Paul, Minn.							
B 4509	Komo Standard Middlings with ground screenings not exceeding mill run	Vulcan	{ G.* F.*	15.0 16.8	4.5 7.1	10.5 10.5	2.75
B 4543	Komo Standard Middlings with ground screenings not exceeding mill run	Daggett	10.3	16.4	6.6	8.6	2.70
		Average	10.9	16.6	6.9	9.6	
Valley City Milling Co. Grand Rapids, Mich.							
B 3412	Rowena Wheat Middlings with ground screenings not exceeding mill run	Grand Rapids	{ G.* F.*	15.5 16.1	4.3 4.1	9.0 6.9	2.25
B 3415	Rowena Wheat Middlings with ground screenings not exceeding mill run	Grand Rapids	10.4	15.6	4.4	7.1	41.00
B 3587	Rowena Wheat Middlings with ground screenings not exceeding mill run	Albion	10.4	15.2	4.6	7.5	40.00
B 3614	Rowena Wheat Middlings with ground screenings not exceeding mill run	Marshall	10.7	15.5	4.6	8.2	43.00

*Abbreviations for Guaranteed and Formal.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Valley City Milling Co., Grand Rapids, Mich.— Con.							
B 3843	Rowena Wheat Middlings with ground screenings not exceeding mill run.....	Wayland	11.1	15.2	4.7	7.2	\$2.35
B 3860	Rowena Wheat Middlings with ground screenings not exceeding mill run.....	Grand Rapids.....	11.3	15.6	4.6	7.0	39.00
B 4208	Rowena Wheat Middlings with ground screenings not exceeding mill run.....	Vicksburg.....	11.0	18.3	4.7	6.6	61.00
B 4849	Rowena Wheat Middlings with ground screenings not exceeding mill run.....	Frankfort.....	11.1	16.1	4.9	7.8	3.00
		Average	10.9	16.0	4.6	7.3	.....
Voigt Milling Co., Grand Rapids, Mich.							
B 3176	Crescent Brand Middlings with mill run screenings.....	Hudsonville.....	10.1	17.1	4.6	6.5	40.00
B 3422	Crescent Brand Middlings with mill run screenings.....	Grand Rapids.....	10.8	15.6	4.2	6.7	2.35
B 3443	Crescent Brand Middlings with mill run screenings.....	Grand Rapids.....	11.7	14.8	4.0	8.7	.....
B 3480	Crescent Brand Middlings with mill run screenings.....	Grand Rapids.....	11.3	15.6	3.3	8.5	2.50
B 4612	Crescent Brand Middlings with mill run screenings.....	Grand Rapids.....	9.3	16.4	4.3	7.5	48.00
B 4806	Crescent Brand Middlings with mill run screenings.....	Petoskey.....	10.5	16.1	4.4	8.0	2.65
		Average	10.6	15.9	4.1	7.7	.....
Washburn Crosby Co., Minneapolis, Minn.							
B 3716	Wheat Flour Middlings with ground screenings not exceeding mill run.....	Owosso.....	10.2	17.2	5.5	4.4	37.00
B 3382	Wheat Standard Middlings with ground screenings not exceeding mill run.....	Detroit.....	11.0	17.6	5.4	8.1	35.00
B 3669	Wheat Standard Middlings with ground screenings not exceeding mill run.....	Lansing.....	9.6	17.4	5.3	8.1	.....
B 3744	Wheat Standard Middlings with ground screenings not exceeding mill run.....	Mason.....	9.6	16.9	5.3	8.5	48.00
B 3789	Wheat Standard Middlings with ground screenings not exceeding mill run.....	South Haven.....	11.2	16.9	5.9	8.1	.....
B 4361	Wheat Standard Middlings with ground screenings not exceeding mill run.....	Ishpeming.....	10.4	17.1	4.6	7.7	52.00
		Average	10.4	17.2	5.3	8.1	.....
WHEAT MIXED FEEDS.							
Consolidated Flour Mills Co., Hutchinson, Kansas.							
B 4479	Wheat Mixed Feed and screenings.....	Holly.....	10.5	17.1	4.2	9.7	2.40
Duluth Superior Milling Co., Duluth, Minn.							
B 4393	Boston Mixed Feed.....	Ewen.....	10.8	16.9	6.1	7.6	3.00
B 4961	Boston Mixed Feed.....	Port Huron.....	9.8	16.6	6.2	9.7	2.75
		Average	10.3	10.8	6.2	8.7	.....
The Huron Milling Co., Harbor Beach, Minn.							
B 4110	Jenks Mixed Feed.....	Carsonville.....	10.9	15.4	4.3	9.3	2.75
B 4124	Jenks Mixed Feed.....	Harbor Beach.....	11.7	14.2	4.2	8.6	52.00
B 4959	Jenks Mixed Feed.....	Port Huron.....	9.7	15.6	4.6	9.0	2.85
		Average	10.8	15.1	4.4	9.0	.....
Kehlror Flour Mills, St. Louis, Mo.							
B 3788	Kehlror's Mill Feed.....	South Haven.....	11.3	17.4	4.2	8.5	50.00
The Lindsborg Milling & Elevator Co., Lindsborg, Kansas.							
B 3164	Wheat Mixed Feed and screenings.....	Zeeland.....	10.7	18.1	4.7	8.7	38.00
B 3849	Wheat Mixed Feed and screenings.....	Sparta.....	10.8	17.4	4.9	7.9	42.00
		Average	10.8	17.8	4.8	8.3	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
National Feed Co., St. Louis, Mo.							
B 1139	Wheat Mixed Feed with screenings not exceeding mill run.	Dundee..... { G.* F.*	15.0 9.8	4.0 19.2	9.0 4.5	8.6	82.75
Portland Milling Co., Portland, Mich.							
B 1982	Champion Mixed Feed	Williamston..... { G.* F.*	13.5 10.6	3.5 11.4	8.4 3.8	7.2	2.70
Stanard Tilton Milling Co., St. Louis, Mo.							
B 1155	Wheat Mixed Feed.	Vassar..... { G.* F.*	13.5 11.5	4.0 18.3	8.0 4.9	8.5	2.10
F. W. Stock & Sons, Hillsdale, Mich.							
B 3944	Monarch Mixed Feed.	Kalamazoo..... { G.* F.*	16.0 10.2	4.0 16.5	10.0 4.3	8.0	52.00
B 1173	Monarch Mixed Feed.	Hillsdale..... { G.* F.*	10.6 10.7	16.6 17.4	4.3 5.0	9.9 8.8	2.85 15.00
B 4175	Monarch Mixed Feed.	Hillsdale..... { G.* F.*	10.6 10.7	16.6 17.4	4.3 5.0	9.9 8.8	2.85 15.00
	Average.....		10.5	16.8	4.5	8.6	
David Stott Flour Mills, Detroit, Mich.							
B 3512	Honest Mixed Feed	Detroit..... { G.* F.*	13.5 11.1	4.0 16.1	8.5 4.1	7.8	
B 3737	Honest Mixed Feed	Detroit..... { G.* F.*	11.5 11.5	15.6 15.6	4.1 4.1	7.3	
	Average.....		11.3	15.8	4.1	7.6	
Valley City Milling Co., Grand Rapids, Mich.							
B 3861	Rowena Cow Feed with ground screenings not exceeding mill run	Grand Rapids..... { G.* F.*	15.0 11.5	4.0 15.1	4.0 4.7	8.1	38.35
B 4861	Rowena Cow Feed with ground screenings not exceeding mill run	Manistee..... { G.* F.*	10.6 11.1	16.6 15.8	4.8 4.8	8.4 8.3	2.85
	Average.....		11.1	15.8	4.8	8.3	
WHEAT AND RYE MIXED FEEDS.							
Commercial Milling Co., Detroit, Mich.							
B 3333	Henkel's Fine White Feed	Detroit..... { G.* F.*	13.0 11.3	4.0 16.4	9.0 4.1	7.1	
B 3358	Henkel's Fine White Feed	Detroit..... { G.* F.*	10.1 10.1	15.1 15.1	3.8 4.1	10.1	
B 3592	Henkel's Fine White Feed	Detroit..... { G.* F.*	9.8 11.1	15.8 15.6	3.8 4.1	6.8 7.1	40.00 34.66
B 3598	Henkel's Fine White Feed	Detroit..... { G.* F.*	11.1 11.4	15.6 15.7	4.1 3.9	7.1 6.1	34.66 38.00
B 3528	Henkel's Fine White Feed	Detroit..... { G.* F.*	11.4 10.9	15.7 17.1	3.9 4.5	6.1 6.4	38.00 49.00
B 3556	Henkel's Fine White Feed	Detroit..... { G.* F.*	10.9 11.9	17.1 16.3	4.5 3.8	6.4 5.7	49.00 2.90
B 4818	Henkel's Fine White Feed	Bozette City..... { G.* F.*	11.9 11.9	16.3 16.3	3.8 3.8	5.7 5.7	2.90
	Average.....		10.9	16.0	4.0	7.2	
B. A. Eckhart Milling Co., Chicago, Ill.							
B 1705	Wheat and Rye Flour Middlings	Oxford..... { G.* F.*	13.0 9.9	4.0 17.1	9.0 4.8	7.3	2.50
RYE FEED.							
(Rye Bran and Rye Middlings with ground screenings).							
John P. Dausman Milling Co., DePere, Wis.							
B 1322	Rye Middlings with ground screenings not exceeding mill run	Cheboygan..... { G.* F.*	12.2 10.5	3.6 16.5	5.0 4.5	6.0 6.8	57.00
Oriental Mills, Manitowoc, Wis.							
B 1813	Rye Feed	Ludington..... { G.* F.*	13.0 11.7	2.5 14.5	6.0 3.3	4.0 4.9	2.60
Valley City Milling Co., Grand Rapids, Mich.							
B 3794	Rowena Rye Feed	Hartford..... { G.* F.*	16.0 10.6	2.2 14.2	6.2 3.1	6.2 5.3	42.00
B 3799	Rowena Rye Feed	Hartford..... { G.* F.*	10.6 10.9	14.2 15.6	3.1 3.2	5.3 5.8	42.00
B 3903	Rowena Rye Feed	Coopersville..... { G.* F.*	11.2 10.4	17.8 15.5	3.3 3.7	4.5 5.8	38.00 2.35
B 3907	Rowena Rye Feed	Hudsonville..... { G.* F.*	11.2 10.4	17.8 15.5	3.3 3.7	4.5 5.8	38.00 2.35
B 1701	Rowena Rye Feed	Saline..... { G.* F.*	11.2 10.4	17.8 15.5	3.3 3.7	4.5 5.8	38.00 2.35
	Average.....		10.7	15.8	3.3	5.5	

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFF FOR 1918-1919.—Continued.

Laboratory number	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Voigt Milling Co., Grand Rapids, Mich.							
B 4615	Crescent Brand Rye Feed.....	Grand Rapids... { G.* F.*	..... 8.6	15.0 15.1	3.0 3.0	6.0 5.3	..... \$16.00
OAT MEAL MILL BY-PRODUCTS.							
Armour Grain Co., Chicago, Ill.							
B 4197	Oat Feed (Composed of ground oat hulls, oat shorts, oat middlings).....	Ypsilanti..... { G.* F.*	..... 6.5	5.0 5.7	2.0 1.9	30.0 30.7	..... 1.50
B 4732	Oat Feed (Composed of ground oat hulls, oat shorts, oat middlings).....	Trenton.....	6.7	5.0	1.8	30.1	1.70
		Average.....	6.6	5.4	1.9	30.4	.....
E. P. Mueller, Chicago, Ill.							
B 3827	Reground Oat Feed (ground oat hulls).....	Holland..... { G.* F.*	..... 8.0	5.9 6.7	2.1 2.1	26.9 24.7	..... 20.00
B 3841	Reground Oat Feed (ground oat hulls).....	Wayland.....	7.2	7.1	2.5	21.6	30.00
B 3906	Reground Oat Feed (ground oat hulls).....	Muskegon Heights.....	7.2	5.2	1.8	29.3	30.00
B 4198	Reground Oat Feed (ground oat hulls).....	Adrian.....	7.4	7.6	1.8	26.1	26.00
B 4281	Reground Oat Feed (ground oat hulls).....	Grand Rapids.....	6.4	4.8	2.0	29.0	28.00
		Average.....	7.2	6.5	2.0	26.8	.....
The Quaker Oats Co., Chicago, Ill.							
B 3481	Vim Feed (Ground oat hulls, oat shorts, oat middlings).....	Forest Grove... { G.* F.*	..... 8.2	5.0 5.8	2.0 1.7	28.0 25.4	..... 32.00
B 3497	Vim Feed (Ground oat hulls, oat shorts, oat middlings).....	Zeeland.....	7.7	5.5	1.5	27.0	30.00
B 3822	Vim Feed (Ground oat hulls, oat shorts, oat middlings).....	Holland.....	7.4	6.8	2.0	26.7	30.00
B 4596	Vim Feed (Ground oat hulls, oat shorts, oat middlings).....	East Jordan.....	6.8	7.4	2.4	25.5	2.00
B 4932	Vim Feed (Ground oat hulls, oat shorts, oat middlings).....	Pontiac.....	7.0	5.1	1.8	28.7	27.28
B 4941	Vim Feed (Ground oat hulls, oat shorts, oat middlings).....	Birmingham.....	7.5	5.2	1.4	28.9	1.40
B 4990	Vim Feed (Ground oat hulls, oat shorts, oat middlings).....	Jackson.....	6.9	6.1	2.3	26.6	.....
		Average.....	7.3	6.0	1.9	27.0	.....
BARLEY FEED.							
The Larabee Flour Mills Corporation, Kansas City, Mo.							
B 4708	Barley Feed (Barley hulls, and barley screenings)...	Oxford..... { G.* F.*	..... 8.4	10.5 8.9	1.7 3.3	22.7 21.1	..... 2.28
Pillsbury Flour Mills, Minneapolis, Minn.							
B 4218	Barley Mill Feed (Barley hulls, barley bran, barley middlings and ground barley screenings).....	St. Joseph..... { G.* F.*	..... 10.0	8.0 13.1	2.0 3.3	20.0 11.7	..... 60.00
B 4425	Barley Mill Feed (Barley hulls, barley bran, barley middlings and barley ground screenings).....	Morenci.....	9.6	11.3	3.2	15.7	53.00
		Average.....	9.8	12.2	3.3	13.7	.....
Postum Cereal Co., Battle Creek, Mich.							
B 4262	Barley Bran (barley hulls).....	Battle Creek... { G.* F.*	..... 6.8	8.0 8.1	1.2 2.2	50.0 19.7	..... 40.00
Star & Crescent Milling Co., Chicago, Ill.							
B 3610	Barley Feed (Barley hulls and barley screenings)...	Marshall..... { G.* F.*	..... 10.2	12.0 11.7	2.5 2.5	13.5 14.6	..... 45.00
B 4168	Barley Feed (By-products from manufacture of pearled barley).....	Litchfield.....	10.7	13.3	2.5	8.5	52.50
		Average.....	16.5	12.5	2.5	11.6	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
CEREAL FOOD BY-PRODUCTS.							
J. E. Bartlett Co., Jackson, Mich.							
B 4164	Toasted Wheat Feed	Litchfield (G. ^a)	15.0	2.0	26.0	.....	.....
B 4167	Toasted Wheat Feed	Litchfield (F. ^b)	9.3	16.1	1.9	7.2	.....
B 4241	Toasted Wheat Feed	Litchfield	6.8	14.4	3.2	11.3	\$38.50
B 4161	Toasted Wheat Feed	Cadillac	7.3	18.2	2.8	20.4	47.00
		Grand Ledge	6.5	17.4	3.3	18.5	.....
		Average	7.5	16.5	2.8	15.1	.....
Kellogg Toasted Corn Flake Co., Battle Creek, Mich.							
B 4265	Broken Wheat Biscuit	Battle Creek (G. ^a)	9.3	0.8	2.4	.....	.....
		(F. ^b)	5.1	12.3	1.3	2.9	.....
B 3741	Dried Corn Flake Feed	Mason (G. ^a)	6.9	2.1	0.4	.....	.....
B 4266	Dried Corn Flake Feed	Battle Creek (F. ^b)	8.5	8.3	3.0	0.7	53.00
B 4735	Dried Corn Flake Feed	Battle Creek	4.3	8.1	1.3	0.6	.....
		Bronson	7.8	8.2	1.8	0.6	2.80
		Average	6.9	8.2	2.0	0.6	.....
Mapl-Flake Mills, Battle Creek, Mich.							
B 4269	Cooked Grits	Battle Creek (G. ^a)	7.0	0.5	0.2	.....	.....
		(F. ^b)	11.9	7.9	1.0	0.7	.....
B 4271	Macaroni Feed	Battle Creek (G. ^a)	15.0	0.2	1.0	.....	.....
		(F. ^b)	12.4	13.7	0.5	0.2	50.00
B 4270	Mapl-Flake Feed	Battle Creek (G. ^a)	7.7	0.6	1.7	.....	.....
		(F. ^b)	3.7	10.7	1.4	0.9	2.25
Postum Cereal Co., Battle Creek, Mich.							
B 4260	Cooked Corn Grits	Battle Creek (G. ^a)	6.0	0.2	2.0	.....	.....
		(F. ^b)	11.2	7.6	0.4	0.4	40.00
B 3174	CXX Feed	(G. ^a)	15.0	2.0	26.0	.....	.....
B 4000	CXX Feed	Janestown (F. ^b)	8.2	18.3	3.3	19.3	38.00
B 4004	CXX Feed	Hastings	8.0	17.6	3.7	19.0	35.00
B 4052	CXX Feed	Dexereaux	7.3	18.9	3.7	18.1	.....
B 4071	CXX Feed	Bay City	7.7	17.4	3.8	18.7	1.75
B 4259	CXX Feed	Caro	8.4	16.9	3.1	19.5	33.00
		Battle Creek	8.0	17.2	3.7	15.4	33.00
		Average	7.9	17.7	3.6	18.3	.....
B 3490	Flaked Corn Feed	(G. ^a)	8.0	1.0	5.0	.....	.....
B 3998	Flaked Corn Feed	(F. ^b)	9.0	8.3	1.0	0.5	51.00
B 4174	Flaked Corn Feed	Nashville	8.1	8.3	1.5	0.7	.....
B 4194	Flaked Corn Feed	Hillsdale	8.3	8.6	1.6	0.8	3.00
B 4261	Flaked Corn Feed	Adrian	7.8	8.5	1.0	0.8	54.00
		Battle Creek	5.5	8.3	1.1	0.8	46.00
		Average	7.7	8.4	1.2	0.7	.....
B 4258	Flaked Corn Offal	(G. ^a)	5.0	0.5	2.0	.....	.....
		(F. ^b)	8.5	8.1	2.0	0.9	45.00
B 4257	G. N. Feed	(G. ^a)	9.0	0.5	2.5	.....	.....
		(F. ^b)	2.0	11.7	0.8	1.2	50.00
Quaker Oats Co., Chicago, Ill.							
B 4163	Maz All Feed	Litchfield (G. ^a)	8.0	1.4	2.0	.....	.....
B 1988	Maz All Feed	Jackson (F. ^b)	6.9	8.6	1.3	1.0	57.50
			7.0	8.9	1.6	1.0	70.00
		Average	7.0	8.8	1.5	1.0	.....
MISCELLANEOUS FEEDS.							
J. E. Bartlett Co., Jackson, Mich.							
B 4991	Linseed (Ground flaxseed screenings and grain screenings)	Jackson (G. ^a)	15.0	8.0	12.0	.....	.....
		(F. ^b)	10.7	17.8	7.5	16.6	2.00

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDING STUFFS FOR 1918-1919.—Concluded.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
B 3861	Bel-Car Mo Nut Butter Co., Grand Rapids, Mich.	Grand Rapids...	(G.* F.* 4.9	19.4 19.4	25.2 25.2	7.8 7.8	.....
B 4608	Blue Bell Peanut Butter Co., Grand Rapids, Mich.	Grand Rapids...	(G.* F.* 4.3	24.0 24.1	30.2 30.3	6.8 6.9	.....
B 4648	Colby Milling Co., Dowagiac, Mich.	Dowagiac.....	(G.* F.* 9.4	13.8 13.1	3.6 3.6	12.8 16.4	..... \$28.00
B 4112 B 4963	Michigan Cereal Co., Port Huron, Mich.	Sandusky.....	(G.* F.* 9.1	5.0 15.2	0.5 1.3	50.0 33.2	..... 2.75
		Port Huron.....	..... ..... 8.8	..... 11.4	..... 0.9	..... 36.8	.....
B 4777	Watson Bros., Detroit, Mich.	Average.....	..... ..... 9.0	..... 13.3	..... 1.1	..... 35.0	.....
		Detroit.....	(G.* F.* 9.5	9.2 10.4	9.5 6.1	2.0 2.3	.....

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDS REQUIRING NO LICENSE.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Amendt Milling Co., Monroe, Mich.							
B 4914	Amco Middlings.....	Plymouth..... { G.* F.*	9.8	17.0 16.8	5.0 4.7	8.0 6.1	\$3.00
B 4915	Barley Meal.....	Plymouth..... { G.* F.*	11.7	11.0 14.6	2.1 3.4	4.8 3.5	2.96
B 4445	Norvell Rye Feed.....	Trenton..... { G.* F.*	10.4	15.9	3.9	5.7	30.00
The J. E. Bartlett Co., Jackson, Mich.							
B 4986	Ground Salvage Barley.....	Jackson..... { G.* F.*	11.5	9.9 15.6	2.6 2.1	7.0	2.25
B 4987	Salvage Wheat.....	Jackson..... { G.* F.*	11.8	12.8	1.8	3.9	2.50
Bay State Milling Co., Winona, Minn.							
B 4323	Low Grade Flour.....	Sault Ste. Marie. { G.* F.*	11.8	16.0 15.8	4.5 4.1	2.0 1.2	50.00
B 4309	Winona Coarse Wheat Bran.....	Alpena..... { G.* F.*	10.4	14.6	6.0	10.8	58.00
Christian Breisch Co., Lansing, Mich.							
B 3704	Choice Winter Wheat Bran.....	Lansing..... { G.* F.*	9.6	13.1	3.5	10.4	.....
B 3676	Choice Winter Wheat Bran.....	Lansing..... { G.* F.*	10.4	14.8	3.2	9.3	40.00
		Average.....	10.0	14.0	3.4	9.9	.....
Commercial Milling Co., Detroit Mich.							
B 3334	Wheat Bran.....	Detroit..... { G.* F.*	10.8	16.7	4.4	10.4	39.00
Eagle Roller Mills Co., New Ulm, Minn.							
B 4397	Superb Red Dog Flour.....	Ironwood..... { G.* F.*	11.3	17.0 17.9	5.0 4.2	7.4 4.4	2.65
J. F. Easley Milling Co., Plainwell, Mich.							
B 4647	Winter Wheat Bran.....	Plainwell..... { G.* F.*	9.7	14.6	4.6	10.2	.....
B 4649	Winter Wheat Bran.....	Plainwell..... { G.* F.*	9.5	14.5	5.9	11.1	.....
		Average.....	9.6	14.6	5.3	10.7	.....
Freme Cereal Co., Minneapolis, Minn.							
B 4989	Ground Barley.....	Jackson..... { G.* F.*	10.6	12.0 11.9	3.0 3.1	9.0 7.8	2.75
Harris Milling Co., Mt. Pleasant, Mich.							
B 3968	Wheat Bran.....	Mt. Pleasant... { G.* F.*	9.2	13.8	5.2	12.2	52.00
B 4851	Wheat Middlings.....	Frankfort..... { G.* F.*	11.5	14.4	4.3	6.2	2.90
Herried Milling Co., Herried, So. Dakota.							
B 4601	Barley Feed.....	Zeeland..... { G.* F.*	10.8	12.2	2.5	6.9	.....
B 4602	Fine Barley Feed.....	Zeeland..... { G.* F.*	11.2	12.1	1.9	6.7	.....
B 3462	Wheat Bran.....	Zeeland..... { G.* F.*	10.8	17.3	4.3	7.3	38.00
B 3461	Wheat Middlings.....	Zeeland..... { G.* F.*	11.4	18.3	5.4	5.1	40.00
Wm. Kelley Milling Co., Hutchinson, Kansas.							
B 3897	Wheat Bran.....	Muskegon..... { G.* F.*	11.0	14.5 16.1	3.5 4.2	11.0 10.1	37.97
Kellogg Toasted Corn Flake Co., Battle Creek, Mich.							
B 4268	Wheat Bran.....	Battle Creek... { G.* F.*	8.6	13.9	3.3	8.3	.....
Millington Milling Co., Millington, Mich.							
B 4162	Wheat Bran.....	Millington..... { G.* F.*	11.6	15.4	3.8	9.9	2.00

*Abbreviations for Guaranteed and Found.

ANALYSES OF FEEDS REQUIRING NO LICENSE.—Continued.

Laboratory number.	Manufacturer and Trade Name.	Sampled at	Moisture.	Crude protein.	Crude fat.	Crude fiber.	Price per ton or cwt.
Lewellyn Bean Co., Grand-Rapids, Mich.							
B 3839	Cull Bean Meal.....	Wayland..... { G_s^* F.*	10.1	22.8	1.5	6.9	\$45.00
B 3867	Cull Bean Meal.....	Allegan..... { G_s^* F.*	10.2	18.0	2.0	10.6	47.00
		Average.....	10.3	20.4	1.8	13.8	.....
State Milling Co., Manhattan, Kansas.							
B 4096	Reliance Mixed Feed.....	Cass City..... { G_s^* F.*	10.9	17.4	5.7	7.9	56.40
Russell-Miller Milling Co., Minneapolis, Minn.							
B 3698	Wheat Occident Feed.....	Lansing..... { G_s^* F.*	9.7	17.8	5.4	7.8	38.50
B 4353	Wheat Occident Feed.....	Negawnee..... { G_s^* F.*	10.8	16.8	5.8	8.8	3.00
B 4570	Wheat Occident Feed.....	Charlevoix..... { G_s^* F.*	9.6	18.6	5.5	8.5	2.65
		Average.....	10.0	17.7	5.6	8.4	.....
F. J. Smith, Pickford, Mich.							
B 4322	Our Own Make Bran.....	Sault Ste. Marie..... { G_s^* F.*	11.0	12.9	4.9	11.9	.....
E 4333	Our Own Make Middlings.....	Sault Ste. Marie..... { G_s^* F.*	12.5	14.9	4.5	6.2	.....
F. W. Stock & Sons, Hillsdale, Mich.							
B 3945	Wheat Bran.....	Kalamazoo..... { G_s^* F.*	10.3	15.4	3.4	9.6	52.60
B 4177	Wheat Bran.....	Hillsdale..... { G_s^* F.*	10.6	16.7	4.7	8.5	43.00
		Average.....	10.5	16.1	4.1	9.1	.....
Van Eyck Weurding Milling Co., Holland, Mich.							
B 3824	Bucksheat Bran.....	Holland..... { G_s^* F.*	12.3	20.1	4.9	8.5	50.00
B 3460	Wheat Middlings.....	Zeland..... { G_s^* F.*	10.5	14.2	3.6	5.9	45.00
Washburn-Crosby Co., Minneapolis, Minn.							
B 4324	Pure Hard Wheat Adrian Red Dog Flour.....	Sault Ste. Marie..... { G_s^* F.*	10.3	16.0	4.0	4.0	50.00
Watson Higgins Milling Co., Grand Rapids, Mich.							
E 3182	Wheat Bran.....	Coopersville..... { G_s^* F.*	10.2	14.3	3.7	2.6	42.00
B 3416	Wheat Bran.....	Grand Rapids..... { G_s^* F.*	10.7	14.8	3.7	8.3	40.00
		Average.....	10.5	14.6	3.7	5.5	.....
B 3853	Wheat Middlings.....	Sparta..... { G_s^* F.*	12.4	16.1	4.0	6.6	44.00

*Abbreviations for Guaranteed and Found.

STUDIES IN THE COST OF MILK PRODUCTION. NO. 2.

Bulletin No. 286.

TERRITORIES STUDIED.

Studies in the cost of market milk production were begun by the Michigan Experiment Station in Kent, Allegan and Ottawa counties in 1913 and were continued throughout a period of two and one-half years. The territory studied supplied milk for the Grand Rapids trade. The results of this investigation were published in Michigan Experiment Station Bulletin No. 277.

Upon the completion of the work in the Grand Rapids field, requests came from the patrons of two condensing districts to have milk cost accounting studies made on their farms. One of these districts was in Livingston county in the vicinity of Howell and the other was in Ingham county, centered about Webberville. The work was started in both fields in the early spring of 1916 and the portion of it included in this report covers the calendar period, March 1, 1916 to March 1, 1919, at Howell, and March 1, 1916 to March 1, 1918, at Webberville. In both of these fields, the milk was sold for condensing purposes with the exception of the last two years at Howell, during which time about one-half of the farmers sold their milk to the Detroit city trade. The Howell territory is an old dairy section, milk production and receipts from dairy cattle being the chief sources of farm income.

TABLE NO. 1.

	Howell (Livingston County).	Webberville (Ingham County).
Fields studied.....	March, 1916 to March, 1919.	March, 1916 to March, 1918.
Years studied.....	3	2
Number of years.....	25	25
Number farms studied each year.....	1239.6	730.8
Total number cows.....	413.2	365.4
Average number cows annually.....	16.5	14.6
Average number cows per herd.....		

In the Webberville territory, dairying had not developed to so great an extent as in the Howell territory, but due to the good market conditions and general adaptability of this district for the dairy business, it is developing rapidly into a pronounced dairy section. The majority of the cattle in this territory were grades, while in the Howell section there was a large number of pure-breds.

BASIS OF STUDY.

In the collection of the data upon which this Bulletin is based, the accountants followed the general plan of Bulletin No. 277 but modified it in some particulars to comply with the outline approved by the Office of Farm Management of the United States Department of Agriculture.

The dairy cow is the unit basis of study. That is, no attempt is made to take other livestock or any other farm enterprise into consideration. Credit is given for the value of the calves as soon as the cows' milk is fit for human consumption, and all heifers are charged into the herd at their actual value as soon as they freshen. All the data presented in this bulletin are given on an average cow basis for each month, and are summarized into seasonal and yearly totals. The calendar month was used for convenience.

METHOD OF OBTAINING DATA.

Cost records were kept on twenty-five representative herds in each territory. The average size of the herds was 16.5 cows at Howell and 14.6 cows at Webberville. These herds were large enough to study with some degree of accuracy.

The College employed a field accountant who spent one day out of each calendar month throughout the year on every farm. He kept an accurate record of the kind and amount of all the feeds which were fed, and of the time spent in performing the various operations in the producing of milk. The monthly data were based on this daily record with the exception of milk sold and incidental costs. He also took into consideration all overhead costs such as investments, veterinary services, deaths, and other miscellaneous costs as well as all receipts for products. A record of the milk sold was secured each month from the dealer. From this statement was obtained the price of the milk, the total value, the cost of transportation from the farm to plant or station, and the percent of butter fat. Incidental expenses were taken from daily records kept by the farmer. These data were also checked up with the day's record taken by the accountant.

COST ITEMS.

1. Feeds:

All feeds grown on the farm and fed to dairy cattle were charged in at their market value at the farmer's barn. When grinding was done, the cost was added to the price of the feeds. All purchased feeds were charged in at their actual cost. Cartage of all feeds was figured in terms of man and horse hours and was credited to labor.

(a) Concentrates.

This item included all the home-grown grains and commercial feeds fed the dairy herd.

(b) Roughages.

All the coarse feeds such as hay, fodder, silage, and green feeds, (green corn, green alfalfa, green peas and oats, roots, etc.) come under this item.

(c) Pasture.

To determine the cost of pasture with any degree of accuracy is a difficult task and one that requires close attention. The method used was to capitalize all permanent pasture and allow 5% interest on investment and 1% for taxes, plus the fence upkeep. The average value of the pasture lands for the two territories studied was \$53.00 per acre. The value of all other pasture, obtained from meadows, etc., was based as nearly as possible on feed consumed, and was either charged in at a weekly rate or on a tonnage basis.

(d) Bedding.

A record was kept of all bedding used outside of what refuse passed through the mangers. Straw was used on all the farms, and the value placed at what it was worth at the barn.

2. Labor:**(a) Man Labor.**

This includes all the time spent in caring for the dairy herd, and is divided under the following headings: Production Labor, Handling Milk and Miscellaneous Labor. These items have been divided into two classes: (1) Labor performed by owner or operator, and (2) Labor performed by hired help. Such labor as has been performed by the family other than the owner or operator has been classified in with the hired help. However, there was a very small amount of this class of labor. The rate of pay for hired help was that actually paid on the several farms. The owner or operator is a more competent laborer as a rule and, therefore, is allowed a somewhat higher wage than that paid the hired help.

(b) Horse Labor.

Horse labor is divided into two classes, hauling feeds and incidental labor. Hauling milk is another big item, part of which should come under horse labor, but due to the fact that nearly all the milk was

hauled in large routes by hired milk haulers under the direction of the milk plants, it is impossible to give this item in terms of hours.

(c) Hauling Milk.

As stated in the preceding paragraph, nearly all milk was hauled by large route wagons under the direction of the milk plant. The cost of hauling was deducted from the farmer's monthly milk statement.

3. Other Costs.

Other costs cover a number of items and are listed under the following headings:

(1) Taxes, Interest and Depreciation on the Herd.

An inventory was taken of each herd at the beginning of the year, and if any changes were made as to the number of cows with their values, it was noted by the accountant and correction was made. Pure-bred cattle were charged as high grades, for the pure-bred business was not considered in this work, due to the fact that only the cost of milk production was under consideration. The charges were divided as follows: Interest, 6%; taxes, 1%, and depreciation, 5%. The tax rate is lower than the average assessed tax rate, but the valuations are higher than most assessors value cattle, and so balances in the end.

There are different methods of determining the depreciation of cattle. One is to take an inventory at the beginning and again at the end of the year, the difference of these two values being depreciation or appreciation. Another method is to take the average productive period of the cow's life, which is from six to seven years, and divide this into the difference between her dairy value and beef value, which would give her yearly depreciation. The following expresses this as a formula.

$$\text{Depreciation} = \frac{\text{Dairy value} - \text{beef value}}{\text{Productive life of cow}}$$

The average productive life of the dairy cow is affected in many ways, such as by udder troubles, abortion, failure to breed, accidents, sickness, etc. The average value of the cows in the Howell territory was \$107.74 and the average beef value was \$70.00. The average cow's beef value was, therefore, \$37.74 less than their dairy value. One-seventh of \$37.74 is \$5.39, the depreciation for one year per cow, and amounts approximately to 5% of the inventory value. This compares very closely with the data taken at Grand Rapids, (Bulletin No. 277). The Webberville data were also figured at this same rate. This makes a total charge of 12% for taxes, interest, and depreciation on the herd.

In the above figures no account has been taken of losses due to death. These are entered under a separate item.

(2) Losses Due to Death.

No herd is immune from death losses. Accidents, tuberculosis, and other diseases help to increase the death rate. The difference between the inventory value of the animal and the amount received for hide or carcass was charged under losses due to death.

(3) Taxes, Interest, Insurance, and Depreciation on Buildings.

The valuation of the dairy plant on each farm was determined by a committee of three men who placed values on the portion of the dairy

barn, yardage, milk house, ice house and water supply, that was used for dairy purposes, including the silo and sufficient space to store all dairy feeds. A charge of 10% was made on the inventory value of these items which is divided as follows: Interest, 6%; taxes, 1%; insurance, 0.4%, and depreciation, 2.6%.

(4) Interest and Depreciation on Equipment.

Under this heading comes milking machines, gasoline engines, separators, cans, pails, coolers, heaters, shovels, forks, carts and many other small items used in the dairy. Six percent interest was charged on the value of this equipment. The rate of depreciation varied greatly on different items of equipment. Milking machines, engines, and separators last much longer than milk cans, pails, coolers, etc., and were allowed a proportionate rate. The rate of depreciation charged at Howell averaged 12.6% which, combined with 6% interest, makes a total charge of 18.6% for interest and depreciation on equipment, while at Webberville the total was 18%.

(5) Veterinary Services and Drugs.

Fees for veterinary services and the cost of drugs, including disinfectants used in the dairy, come under this heading.

(6) Sire Costs.

Sire costs are less tangible than general herd costs. Such data as were kept showed that the cost of keeping the sire was approximately equal to the value of the calves at four days old. In the Howell district nearly every farmer kept a bull, thus making the cost higher than it is in some sections where fewer bulls are kept. In this bulletin sire costs and value of calves at birth are allowed to balance each other.

(7) Miscellaneous Costs.

Under this heading come a large number of items such as gasoline, lubricating oil, fuel for the boiler or heater, washing powder, ice, repairs, dairy literature, association fees, and many other small expenses.

(8) Managerial Ability and Business Risks.

No enterprise can be operated successfully without skilled supervision. The dairy business is of such a nature that it requires the closest of attention at all times throughout the year. A few hours' neglect means a lessening of production, and in time, a failure of the business. The manager must keep in close touch with each and every operation. He must look after the rations for the dairy herd, the selection and purchase of feed, the selecting of the herd sire, the breeding records, the buying and selling of cattle and the general supervision of all help. While in many cases the manager does all or a part of the ordinary dairy work such as milking, feeding, cleaning barns, etc., his time has not been figured in for managerial operations on the time unit basis.

The dairyman should also be entitled to a sufficient amount to cover all business risks such as a temporary loss of market due to the shortage of material in the manufacture of the finished products, strikes, and in some cases where plants discontinue the business for the time being. For this added effort and ability expended over that of ordinary labor and unavoidable risks, 10% of all other expenses have been allowed.

CREDITS.

The following items are classed as credits:

(1) Milk, (2) Manure, (3) Feed Bags, (4) Calves.

(1) Milk.

The largest credit item is milk which is divided as follows: Milk sold, milk used on the farm, and milk not taken by the plant.

A record was kept of all the milk used on the farm and credited to the dairy at prevailing prices less the cost of hauling. Returned milk was valued at what it was worth for stock feeding. A record of the milk sold was taken off the monthly milk statement given the farmer by the manager of the milk plant.

(2) Manure.

The amount of manure credited to the cow for the year was 8 tons for every 1,200 pounds of animal weight. This was divided up according to the seasons. During the winter period (October 16 to May 15) twice as much manure was credited to the cow per month as during the summer season (May 15 to October 16). During the winter when the cows are fed large quantities of rich grains, the manure is richer in fertilizing ingredients than during the summer period. Furthermore, it is true that there is a greater loss in the summer than in the winter.

All manure was valued in the pit or spreader at the barn and was charged in at \$2.00 per ton for the entire yearly production with the exception of the first year when it was charged at \$1.50 per ton.

(3) Feed Bags.

This is a very small item and was not kept separate until the last year's work at Howell. Previous to this, the price of feed bags when sold or returned, was deducted from the cost of the feed purchased.

(4) Calves.

The raising of calves was not considered as a part of the milk cost, therefore, they were charged off the list as soon as the dams' milk was good for human consumption. When whole milk was fed to calves it was charged and classed under the heading "Milk Used on the Farm." As previously stated under "Sire Costs," calves and sire costs offset one another.

THE DATA.

The data are presented on the basis of the average per cow of the entire field, and are given for each calendar month as well as by the season and the year. No attempt will be made to go into individual herd records in this bulletin, due to the large amount of space they would require. Nevertheless all these herd records are on file and may form parts of future publications.

The winter season covers the winter feeding period (October 15 to May 16) and the summer season covers the summer feeding period or pasture season (May 16 to October 15). These dates were selected as being the nearest point of demarcation between the two seasons.

Feed Costs.

Feeds constitute the largest item of expense in the dairy business, comprising nearly one-half (48.9% at Howell and 46.4% at Webberville) of the total cost of milk production.

Tables II and III give the amount of feed fed per cow for each month as well as for the winter and summer season and the yearly total.

TABLE II.—AVERAGE MONTHLY FEED REQUIREMENT PER COW AT HOWELL.

Three bottom lines of the table show the amounts of feed for winter and summer seasons and the yearly total.

Months.	Home grown grains.	Commercial feeds.	Hay.	Other dry roughage.	Silage.	Soiling crops and other succulent feeds.	Pasture.	Bedding used.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	days	lbs.
March.....	90	151	378	103	1074	1	.....	127
April.....	72	131	414	53	944	5	.....	123
May.....	47	76	203	37	436	5	18	68
June.....	17	41	31	.....	52	1	30	17
July.....	10	38	45	1	25	6	31	4
August.....	19	41	65	7	69	27	34	8
September.....	35	54	86	7	174	161	20	27
October.....	54	81	145	49	437	127	20	64
November.....	85	109	267	129	843	40	.....	103
December.....	84	139	330	159	1026	54	.....	127
January.....	82	172	327	156	1118	22	.....	128
February.....	95	142	297	124	995	8	.....	123
Winter season.....	573	938	2305	791	6687	219	8	822
Summer season.....	117	240	283	34	506	241	152	97
Yearly.....	690	1178	2588	825	7193	460	160	919

TABLE III.—AVERAGE MONTHLY FEED REQUIREMENT PER COW AT WEBBERVILLE.
Three bottom lines of the table show the amounts of feed for winter and summer seasons and the yearly total.

Months.	Home-grown grains.	Commercial feeds.	Hay.	Other dry roughage.	Silage.	Soiling crops and other succulent feeds.	Pasture.	Bedding used.
	lbs.	lbs.	lbs.	lbs.	lbs.	days	lbs.	lbs.
March.....	101	110	360	132	989	.....	.....	124
April.....	98	72	354	82	834	.....	.....	104
May.....	40	28	94	1	267	.....	16	41
June.....	10	9	13	.....	38	.....	30	9
July.....	5	7	23	.....	58	6	31	3
August.....	3	8	48	4	92	9	31	1
September.....	18	16	58	37	120	100	30	5
October.....	43	34	122	98	336	105	15	41
November.....	48	51	212	236	785	38	.....	88
December.....	58	70	317	212	1078	15	.....	122
January.....	65	94	306	226	1140	.....	.....	137
February.....	72	81	320	149	1006	.....	.....	120
Winter season.....	499	521	2045	1100	6315	88	.....	763
Summer season.....	62	59	182	77	427	185	153	32
Yearly.....	561	580	2227	1177	6742	273	153	795

The average amount of grain fed per cow per year at Howell was 1,868 pounds, of which 37%, or 690 pounds, was home-grown. At Webberville 1,141 pounds of grain were fed per cow, of which 49.2%, or 561 pounds, was home-grown. The home-grown grains consisted of oats, corn, and barley with the amounts of each in the order given.

The price of silage was based on the cost of growing and harvesting the crop. From records kept on 50 farms in 1918 it was shown that the average cost equalled \$8.46 per ton. This high cost is attributed largely to the low tonnage yield for that year, due to a very unfavorable corn season. The prices of silage varied from \$4.40 per ton in 1916 to \$8.46 per ton in 1918 in the two districts.

The average length of time the cattle were on pasture was 157.2 days, costing an average of \$7.57 at Howell and \$8.20 at Webberville per cow per year. As a whole the Webberville district furnished more abundant pasture, thus cutting down on the amount of supplementary feed fed during the summer season as compared with the Howell territory. As previously stated, the cost of all permanent pasture was based on the capitalized value of the land, allowing 5% for interest and 1% for taxes, plus the upkeep of the fences. All pasture secured from meadows or fields not classed as permanent pasture was charged in according to the amount of feed furnished, either at a weekly rate or on a tonnage basis.

The large increase in cost of feeds is attributed to the world war which caused a general upward trend for all commodities. The increased cost of silage in 1918 was due to the poor corn season for that year, resulting in a very light tonnage of silage per acre. It will be noted that the feed cost per cow at Howell was greater than at Webberville. This is due to the fact that the larger and heavier producing cows

at Howell required more feed; and also that more commercial feeds, which are higher priced than the home-grown grains, were fed.

Labor Costs.

Labor is the second largest item in the cost of milk production. A detailed record of the labor was kept which was divided as follows: Production labor, handling milk, and miscellaneous labor. These items are still further divided into two classes. (1) labor performed by the owner or operator, (2) labor performed by hired help. At Howell the average production labor per cow was 136.4 hours, handling milk 3.1 hours, while the miscellaneous labor amounted to 7.6 hours, making a total of 147.1 hours for the year. Of the total amount, 43.6% or 64.1 hours, was spent by the owner or operator.

The total time spent at Webberville amounted to 116.7 hours per cow per year, of which 58.0% was performed by the owner or operator.

TABLE IV.—AVERAGE MONTHLY LABOR REQUIREMENT PER COW AT HOWELL.

Three bottom lines of the table show the labor requirement for winter and summer seasons and yearly total.

Month.	Production labor. Hours	Handling milk. Hours	Miscellaneous labor. Hours	Labor performed by owner or operator. Hours	Labor performed by hired help. Hours	Total man labor. Hours	Horse labor. Hours
March.....	13.5	0.4	0.9	6.2	8.6	14.8	1.0
April.....	12.5	.4	.9	5.6	8.2	13.8	.8
May.....	12.5	.3	.5	5.6	7.7	13.3	.5
June.....	10.0	.2	.4	4.7	5.9	10.6	.3
July.....	9.1	.3	.4	4.0	5.8	9.8	.2
August.....	8.2	.3	.3	3.8	5.0	8.8	.3
September.....	7.5	.2	.5	3.4	4.8	8.2	.4
October.....	9.6	.2	.6	4.5	5.9	10.4	.6
November.....	11.9	.2	.7	5.9	6.9	12.8	.8
December.....	13.6	.2	.8	6.8	7.8	14.6	.9
January.....	14.7	.2	.8	7.2	8.5	15.7	1.0
February.....	13.3	.2	.8	6.4	7.9	14.3	.9
Winter season.....	91.5	1.9	5.7	43.6	55.5	99.1	6.1
Summer season.....	44.9	1.2	1.9	20.5	27.5	48.0	1.6
Yearly.....	136.4	3.1	7.6	64.1	83.0	147.1	7.7

TABLE V.—AVERAGE MONTHLY LABOR REQUIREMENT PER COW AT WEBBERVILLE.
Three bottom lines of the table show the labor requirement for winter and summer seasons and yearly total.

Month.	Production labor.	*Handling milk.	Miscellaneous labor.	Labor performed by owner or operator.	Labor performed by hired help.	Total man labor.	Horse labor.
	Hours	Hours	Hours	Hours	Hours	Hours	Hours
March.....	10.4	1.0	0.9	7.5	4.8	12.3	.78
April.....	9.6	1.0	.8	6.6	4.8	11.4	.69
May.....	8.0	1.2	.7	5.4	4.5	9.9	.32
June.....	7.3	1.3	.4	4.9	4.1	9.0	.10
July.....	6.4	1.3	.5	4.5	3.7	8.2	.09
August.....	5.2	1.1	.4	3.8	3.9	6.7	.10
September.....	5.3	.9	.5	3.9	3.8	6.7	.19
October.....	6.6	1.1	.7	4.8	3.6	8.4	.29
November.....	7.7	1.0	.7	5.8	3.6	9.4	.35
December.....	9.2	1.1	.8	6.4	4.7	11.1	.42
January.....	10.1	1.2	1.0	7.1	5.2	12.3	.51
February.....	9.1	1.2	1.0	7.0	4.3	11.3	.49
Winter season.....	64.3	7.7	6.0	45.7	32.3	78.0	3.75
Summer season.....	30.6	5.7	2.4	22.0	16.7	38.7	.57
Yearly.....	94.9	13.4	8.4	67.7	49.0	116.7	4.32

*Includes time spent in cleaning utensils.

The price of common labor was based on what was actually paid the farm laborer each month throughout the year.

The cost of common labor rose steadily during the period which was covered by these studies, increasing from \$0.17 to \$0.202 in two years at Webberville, and from \$0.178 to \$0.232 per hour during the three years at Howell.

TABLE VI.—AVERAGE HOURLY LABOR PRICE FOR EACH YEAR STUDIED AT HOWELL AND WEBBERVILLE.

Year.	1916-17.		1917-18.		1918-19.	
	Owner's or operator's labor.	Common labor.	Owner's or operator's labor.	Common labor.	Owner's or operator's labor.	Common labor.
Howell.....	per hr. \$0 25	per hr. \$0 178	per hr. \$0 30	per hr. \$0 204	per hr. \$0 35	per hr. \$0 232
Webberville.....	0 25	0 170	0 30	0 202		

The owner or operator is allowed a higher rate of pay than that of the common laborer because of greater efficiency in performing the same class of work, or in other words, he is a higher paid hired man. The kind of labor performed by the owner or operator is of the same sort as that done by the common laborer and this extra compensation does not

cover any time spent in managing the business. An extra allowance is made for this class of labor and comes under the heading "Managerial Ability and Risks."

While the labor requirement per cow when compared with records taken in other territories, is low, it was possible to give the cattle reasonably good care with the time spent. However, at Webberville, no doubt more time could have been spent to advantage.

The amount of horse labor in these fields was not large, being an average of 7.7 hours at Howell and 4.3 hours at Webberville per cow for the year. Most of the horse labor was spent in hauling feeds. A flat rate of ten cents per hour for the first year and fifteen cents per hour for the last two years was charged against horse labor, amounting to \$1.01 at Howell and \$0.53 at Webberville per cow per year. As already stated, the time used in hauling milk was not taken into consideration (with the exceptions of a few cases where farmers hauled their own milk) because nearly all the farmers hired their milk hauled at a definite rate. As shown in Table VII there was a steady and marked increase in the cost of hauling milk.

TABLE VII. COST OF HAULING MILK PER COW AND PER HUNDRED WEIGHT AT HOWELL AND WEBBERVILLE.

Year.	1916-1917.		1917-18.		1918-19.	
	Per Cow.	Per Cwt.	Per Cow.	Per Cwt.	Per Cow.	Per Cwt.
Howell.....	\$7.84	\$.140	\$9.77	\$.176	\$12.31	\$.221
Webberville.....	\$7.63	\$.144	\$9.10	\$.173	.....	.....

As a whole, milk hauling was done very economically in these two fields and for much less than would have been the case, had the farmers been compelled to haul their own milk.

Other Costs.

Under this heading comes the investment charges in cattle, buildings, and equipment; losses due to death; veterinary services and drugs; sire costs; miscellaneous costs; and charges for management and risks. A total summary of these costs is given in Tables VIII and IX. In order to cut down on space these items are not given separately in monthly cost tables, but are discussed separately under their proper headings.

TABLE VIII.—FEED, LABOR AND OTHER COSTS BY THE MONTH PER COW AT HOWELL.

The three bottom lines of the table show the costs for winter and summer seasons and the yearly totals.

Year.	1916-17.				1917-18.				1918-19.			
	1Feed costs.	2Labor costs.	3Other costs.	Total costs.	1Feed costs.	2Labor costs.	3Other costs.	Total costs.	1Feed costs.	2Labor costs.	3Other costs.	Total costs.
March.....	\$8 21	\$4 00	\$4 08	\$16 29	\$9 00	\$4 55	\$4 60	\$18 15	\$15 47	\$5 27	\$5 68	\$26 42
April.....	8 01	3 90	3 74	15 65	8 47	4 22	4 59	17 28	13 57	4 89	5 15	23 61
May.....	3 66	3 47	3 51	12 64	6 11	4 23	4 27	14 61	7 66	5 07	4 63	17 38
June.....	3 31	3 00	3 38	9 69	3 53	3 92	4 02	11 47	4 26	3 92	4 25	12 43
July.....	2 47	2 58	3 43	8 48	2 56	3 10	3 83	9 58	3 66	3 60	4 13	11 39
August.....	2 57	2 30	3 15	8 02	2 67	2 50	3 50	8 67	4 32	3 23	4 32	11 87
September.....	3 35	2 14	3 21	8 70	3 38	2 17	3 79	9 34	6 37	3 18	5 09	14 64
October.....	4 82	2 78	3 55	10 95	6 65	3 16	4 25	14 06	8 52	3 99	4 75	17 26
November.....	6 75	3 36	4 32	14 43	10 31	3 81	4 64	18 76	12 80	5 11	5 41	23 32
December.....	7 52	3 79	4 78	16 09	13 32	4 78	4 95	23 25	16 19	5 76	6 03	28 00
January.....	8 80	4 25	5 43	17 48	14 90	5 17	5 54	25 61	16 04	6 13	5 74	28 81
February.....	8 34	3 93	4 13	16 40	13 28	4 57	5 10	22 95	14 83	5 97	5 41	26 21
Winter Season....	\$54 67	\$26 50	\$29 12	\$110 29	\$77 52	\$30 93	\$33 84	\$142 29	\$99 28	\$38 51	\$38 35	\$176 14
Summer Season..	15 14	13 00	16 39	44 53	16 86	15 34	19 24	51 44	25 31	17 61	22 28	65 20
Yearly.....	69 81	39 50	45 51	154 82	94 38	46 27	53 08	193 73	124 59	56 12	60 63	241 34

1Includes cost of all feeds and bedding.

2Includes cost of man labor, horse labor and hauling milk.

3Includes all investment and depreciation charges on cattle, buildings, and equipment, also losses due to deaths, veterinary services and drugs, miscellaneous costs, and for managerial ability and risks.

TABLE IX.—FEED, LABOR AND OTHER COSTS BY THE MONTH PER COW AT WEBBERVILLE.

The three bottom lines of the table show the costs for winter and summer seasons and the yearly total.

Year.	1916-17.				1917-18.			
Month.	¹ Feed Costs.	² Labor Costs.	³ Other Costs.	Total Costs.	¹ Feed Costs.	² Labor Costs.	³ Other Costs.	Total Costs.
March.....	\$7 44	\$3 78	\$3 29	\$14 51	\$8 04	\$3 99	\$3 79	\$15 82
April.....	5 90	3 31	3 19	12 40	7 70	3 87	3 78	15 35
May.....	3 09	3 08	2 91	9 08	4 54	3 36	3 76	11 66
June.....	2 24	2 65	2 71	7 60	3 11	3 09	3 52	9 72
July.....	1 73	2 14	2 68	6 55	2 77	2 79	3 55	9 11
August.....	1 56	1 85	2 45	5 86	2 41	2 14	3 25	7 80
September.....	1 93	1 77	2 53	6 23	2 95	2 20	3 27	8 42
October.....	3 20	2 23	2 93	8 36	4 98	2 77	3 51	11 26
November.....	5 11	2 52	3 00	10 63	8 34	3 37	4 27	15 98
December.....	6 33	3 10	3 35	12 78	11 82	3 94	4 37	20 13
January.....	7 33	3 43	3 59	14 35	12 95	4 45	4 54	21 94
February.....	6 83	3 30	3 64	13 77	12 27	4 14	4 57	20 98
Winter Season.....	\$40 68	\$22 26	\$22 93	\$85 87	\$66 87	\$27 24	\$29 07	\$123 18
Summer Season.....	12 01	10 90	13 34	36 25	15 01	12 87	17 11	44 99
Yearly.....	52 69	33 16	36 27	122 12	81 88	40 11	46 18	168 17

¹Includes cost of all feeds and bedding.

²Includes cost of man labor, horse labor, and hauling milk.

³Includes all investment and depreciation charges on cattle, buildings, and equipment, also losses due to deaths, veterinary services and drugs, miscellaneous costs, and for managerial ability and risks.

INTEREST, TAXES, AND DEPRECIATION ON CATTLE.

There has been a general trend of increased values on all the investments during the three years covered by this Bulletin. Cattle increased in value per cow from \$99.17 in 1916-17 to \$114.50 in 1918-19 at Howell, and at Webberville, from \$67.08 in 1916-17 to \$97.42 in 1917-18. On these investments 12% was charged (page 403) with the exception of the last year at Howell when 13.0% was charged, making an average investment charge of \$13.31 per cow at Howell and \$9.87 at Webberville.

LOSSES DUE TO DEATH.

Death losses were not figured under the heading of depreciation, as they have been by some investigators, but were reported under a separate heading. The losses due to death at Howell amounted to \$1.70 per cow, or 1.58% of the total inventory value of the herds. 2% of the cows died in this territory. At Webberville, slightly less than one per cent of the cows died, amounting to a loss of \$0.65 per cow, or .79% of the inventory value of the herds.

INTEREST, TAXES, INSURANCE AND DEPRECIATION ON BUILDINGS.

Building costs varied greatly on the various farms, averaging \$134.93 per cow at Howell and \$113.95 at Webberville. On this investment a total charge of 10% was levied (page 403), amounting to an average for the three years of \$13.49 at Howell, and \$11.40 for the two years at Webberville.

TAXES, INTEREST, AND DEPRECIATION ON EQUIPMENT.

As previously stated (page 404), equipment covers milking machines, gas engines, separators, cans, pails, coolers, shovels, forks, carts, etc. These items were inventoried at \$13.77 per cow at Howell and at \$16.94 at Webberville. Thirty-four farms out of the fifty studied had milking machines, thus increasing the cost of equipment materially. On investments of this sort, 18.6% was charged at Howell, making a total cost of \$2.56 per cow for the year. At Webberville 18% was charged on the investment, which amounted to \$3.05 per cow per year.

VETERINARY SERVICES AND DRUGS.

This item of expense amounts to an average of \$1.02 at Howell and \$0.35 at Webberville per cow per year.

SIRE COSTS.

The work done in keeping the records of sire costs was not sufficient to warrant the use of any data of this sort in this Bulletin. The same method was, therefore, used as was given in Bulletin No. 277 of this Station, that is, sire costs were offset by calves at birth or at the age when their dams' milk is good for human consumption. All sires used at Howell were pure-bred Holsteins, and at Webberville pure-bred Holstein sires predominated.

MISCELLANEOUS COSTS.

These costs cover a large number of minor items which are discussed on page 404. At Howell the miscellaneous costs amounted to \$2.64 per cow in 1916-17 and \$3.66 in 1918-19, and at Webberville the average cost was \$2.31 per cow in 1916-17 and \$3.14 in 1917-18.

MANAGERIAL ABILITY AND RISKS.

Article 8 (page 404) gives a full description of this item, which is charged at 10% of all the total costs entering into milk production and amounting to an average of \$17.87 at Howell and \$13.19 at Webberville per cow per year. It has been figured that where herds are of sufficiently large size to employ a manager to devote his full time to the dairy, it would take the entire amount of this managerial charge to pay him for his services above the cost of common labor.

Tables VIII and IX give a general summary of all costs for each month as well as for the winter and summer seasons and for the yearly total. During the three years studied at Howell, there was a rapid increase in cost due to the war conditions. In 1916-17, which might be called the pre-war period, the costs per cow were \$154.82, while during the following two years the costs per cow were \$193.73 and \$241.34 respectively, thus increasing the costs of the last year over the costs of the first year an amount equaling \$86.52. The cost of feeds increased 78.4%, labor 42.1%, and the other costs 33.2% or a total increase of 55.9%.

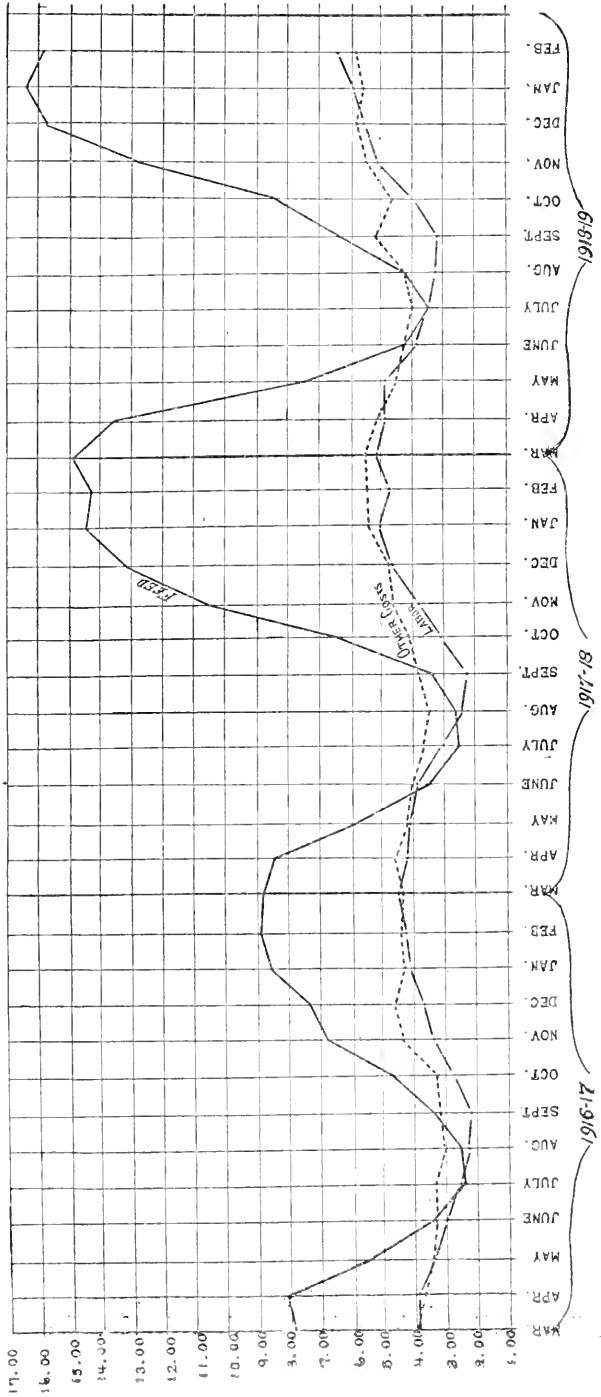


FIG. 1. AVERAGE COST OF FEED, LABOR AND OTHER COSTS PER COW BY THE MONTH AT HOWELL.

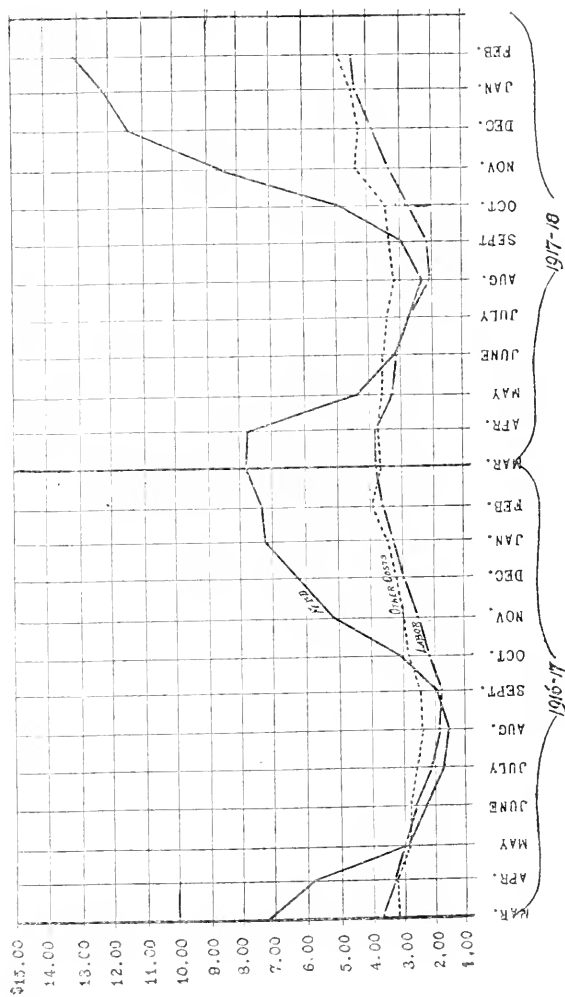


FIG. II. AVERAGE COST OF FEED, LABOR AND OTHER COSTS PER COW BY THE MONTH AT WEBBERVILLE.

At Webberville the total gross cost was \$122.12 per cow for the first year and the last year the costs were \$168.17, or an increase of 37.7%.

TABLE X.—AN AVERAGE PERCENTAGE OF FEEDS, LABOR, AND OTHER COSTS FOR EACH SEASON AND THE YEARLY TOTAL FOR HOWELL AND WEBBERVILLE.

Season.	Howell Territory. (3 year average)			Webberville Territory. (2 year average)		
	Winter Season.	Summer Season.	Yearly.	Winter Season.	Summer Season.	Yearly.
Feeds.....	51.0%	35.6%	48.9%	51.4%	33.3%	46.4%
Labor.....	22.4%	28.5%	24.1%	23.7%	29.2%	25.2%
Other Costs.....	23.6%	35.9%	27.0%	24.9%	37.5%	28.4%
Total.....	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table X shows how the various costs were distributed for each season and the year. As a whole, the per cent of feed, labor and other costs are quite uniform in the two fields studied. At Howell, feeds represented 48.9% of the yearly cost, while at Webberville, they amounted to 46.4% of the yearly cost.

MILK PRODUCTION AND DISPOSAL.

The heavier milk production in both localities was during the winter months which can be attributed to the large percentage of the fall freshened cows. The average production in the two fields for the winter period per cow per month was 631 pounds and for the summer period, 444 pounds or approximately two-thirds of the flow of the winter months.

At Howell a total of 4,766 pounds of milk was produced during the seven winter months, and 2,445 pounds in the five summer months, or a total of 7,211 pounds of milk testing 3.35% per cow per year for the three years' average. Of the total milk produced, 77.5% was sold, 22.2% used on the farm, and .3% was returned from the factory and used on the farm for feeding purposes.

TABLE XI.—MONTHLY MILK PRODUCTION AND DISPOSAL PER COW AT HOWELL.

The three bottom lines of the table show the milk production and disposal for winter and summer seasons, and yearly total.

Year.	1916-17.				1917-18.			
Month.	Milk sold. lbs.	Milk used on farm. lbs.	Milk returned from plant. lbs.	Total milk produced. lbs.	Milk sold. lbs.	Milk used on farm. lbs.	Milk returned from plant. lbs.	Total milk produced. lbs.
March.....	625	102	.....	727	620	142	0.6	763
April.....	597	98	.9	696	551	154	1.7	707
May.....	627	138	4.0	769	602	155	1.5	757
June.....	565	125	1.7	692	580	122	4.2	706
July.....	359	114	18.9	492	389	109	2.8	501
August.....	274	90	1.3	365	239	103	1.5	344
September.....	217	93	.9	311	206	97	.....	303
October.....	287	143	.7	431	298	107	.7	406
November.....	387	148	.....	535	409	133	1.3	543
December.....	503	153	.....	656	539	145	2.4	686
January.....	609	147	.....	756	595	165	.....	760
February.....	568	143	.....	711	541	133	1.1	675
Winter Season.....	3,745	939	1.0	4,685	3,711	1,012	6.0	4,729
Summer Season.....	1,873	555	27.4	2,455	1,858	553	10.7	2,422
Yearly.....	5,618	1,494	28.4	7,140	5,569	1,565	16.7	7,151
1918-19.					Three year average, 1916-19.			
March.....	582	144	4.1	730	609	129	1.6	740
April.....	557	131	3.2	691	568	128	1.9	698
May.....	577	149	6.6	733	602	147	4.0	753
June.....	517	166	3.0	686	554	138	2.9	695
July.....	352	146	1.7	500	367	123	7.4	497
August.....	247	120	1.0	368	253	104	1.3	358
September.....	243	108	.5	352	222	99	.5	322
October.....	326	125	.....	451	304	125	.5	429
November.....	402	160	.2	562	399	147	.5	547
December.....	534	169	.....	703	525	156	.8	682
January.....	627	175	1.1	803	611	162	.4	773
February.....	617	149	.5	766	575	142	.5	717
Winter Season.....	3,794	1,078	13.3	4,885	3,750	1,009	6.8	4,766
Summer Season.....	1,787	664	8.6	2,460	1,839	591	15.5	2,445
Yearly.....	5,581	1,742	21.9	7,345	5,589	1,600	22.3	7,211

TABLE XII.—MONTHLY MILK PRODUCTION AND DISPOSAL PER COW AT WEBBERVILLE.

The three bottom lines of the table show the milk production and disposal for winter and summer seasons and yearly total.

Year.	1916-17.					1917-18.					Two year average 1916-18.				
	Milk sold.	Milk used on farm.	Milk returned from plant.	Total milk produced.	Milk sold.	Milk used on farm.	Milk returned from plant.	Total milk produced.	Milk sold.	Milk used on farm.	Milk returned from plant.	Total milk produced.	Milk sold.	Milk used on farm.	Total milk produced.
Month.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
March.....	609	73	.....	682	612	66	.....	679	610	70	0.4	681	610	70	681
April.....	539	68	0.6	608	560	69	.....	629	550	69	.3	619	550	69	619
May.....	610	53	.9	664	572	50	.....	623	591	51	.7	643	591	51	643
June.....	507	65	5.2	577	501	41	5.2	547	504	53	5.2	562	504	53	562
July.....	339	53	3.5	396	321	40	4.9	366	330	47	4.2	381	330	47	381
August.....	237	51	.8	289	212	34	1.2	247	225	42	1.0	268	225	42	268
September.....	224	64	.5	288	211	60	.....	271	218	62	.3	280	218	62	280
October.....	281	85	1.5	367	300	73	.....	373	290	79	.7	370	290	79	370
November.....	377	79	.3	456	376	68	.....	444	377	73	.2	450	377	73	450
December.....	479	72	.....	551	486	65	.....	551	482	69	.....	551	482	69	551
January.....	570	77	.....	647	552	76	.....	628	561	76	.....	637	561	76	637
February.....	539	53	.....	592	552	67	.....	619	545	60	.....	605	545	60	605
Winter Season.....	3,552	491	1.7	4,045	3,606	477	.9	4,084	3,579	484	1.3	4,064	3,579	484	4,064
Summer Season.....	1,759	302	11.6	2,062	1,649	232	11.8	1,893	1,704	267	11.7	1,983	1,704	267	1,983
Yearly.....	5,311	793	13.3	6,117	5,255	709	12.7	5,977	5,283	751	13.0	6,047	5,283	751	6,047

At Webberville the production was lower, averaging for the two years, 6,047 pounds per year, divided as follows: milk sold, 87.4%, used on the farm, 12.4%, and returned from the factory, .2%. During the winter season 4,064 pounds were produced and during the summer season, 1,983 pounds, making a total of 6,047 pounds for the year with an average test of 3.45% butter fat.

Throughout the three years studied, milk production at Howell was very uniform. The high point of production was during the months of January, February, March, April, May, and June (figure III), while the extreme low points were in August and September. At Webberville the production was less per cow than that at Howell, but ran practically parallel throughout the year.

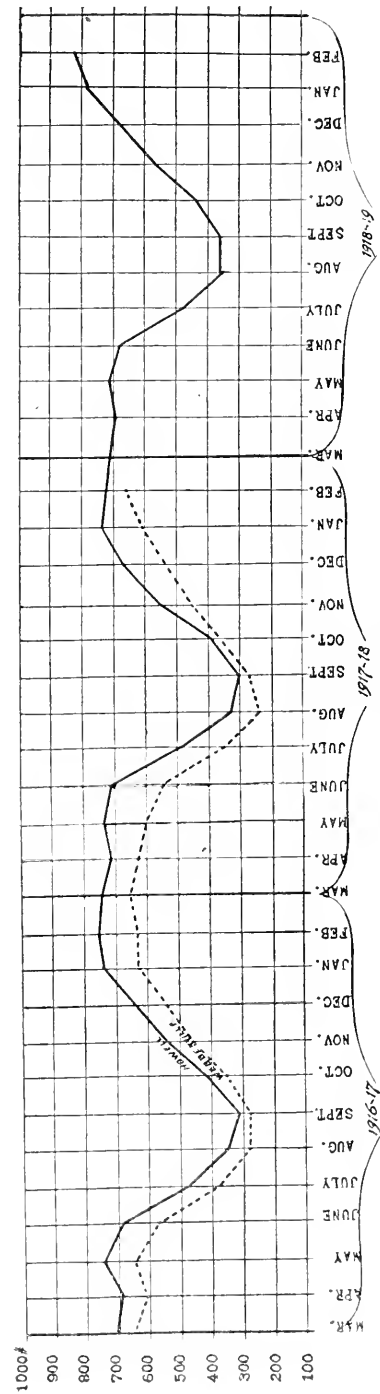


FIG. III. AVERAGE YIELD PER COW BY THE MONTH AT HOWELL AND WEBBERVILLE.

CREDIT VALUES.

In order to determine the net cost of the milk sold, the value of all other products is subtracted from the gross cost of all milk produced. The value of the credits for each year studied, as well as for each month and season, is given in Tables XIII and XIV. Milk used on the farm, milk returned from the milk plant, the manure and the calves comprise the total credits.

The methods for determining the quantity of manure produced are given under the heading "Manure" on page 405. The average amount per year of manure credited to the dairy cow for the three years at Howell was 5.34 tons for the winter season and 2.195 tons for the summer season, making a total of 7.535 tons for the year. A value of \$1.50 per ton was allowed the first year and \$2.00 per ton thereafter, making a total of \$11.60 for the first year, \$15.08 for the second year and \$14.76 for the third year.

At Webberville this item amounted to 6.97 tons per cow, valued at \$10.46 for the first year, and 7.12 tons, valued at \$14.24 for the second year.

All milk used on the farm was valued at the market prices less the cost of hauling. Milk returned from the plant, due to poor condition, was charged in at its feeding value. In some cases where farmers did not have stock to which it could be fed, it was considered a total loss. As a whole this was a very small item and amounted to only fifteen cents per cow per year at Howell and seven cents per cow per year at Webberville.

A separate account was kept on feed bags sold during the last year's work at Howell. This amounted to twenty cents per cow. Previous to this year when feed bags were sold, their value was deducted from the cost of feed.

No value for calves is given. As previously stated, calves at birth were offset by sire costs.

The total value of the credits for the year amounted to \$34.21 for the first year, \$49.18 for the second year, and \$60.02 for the third year per cow at Howell and \$22.88 for the first year and \$30.20 for the last year at Webberville.

COST OF MILK SOLD.

No one factor tends to raise or lower the cost of production of milk as much as does the quantity of milk produced. The average production in the Howell field was 7,211 pounds per cow per year, ranging much higher than the average production throughout the state which is estimated at about 4,500 pounds.

TABLE XIII.—CREDITS FOR PRODUCTS OTHER THAN MILK SOLD PER COW PER MONTH AT HOWELL.

The three bottom lines of the table show the credits for products other than milk for winter and summer seasons and the yearly total.

Year.	1916-17.				1917-18.				1918-19.			
	Manure.	Milk used on farm.	Milk returned from plant.	Total.	Manure.	Milk used on farm.	Milk returned from plant.	Total.	Manure.	Milk used on farm.	Milk returned from plant.	Total.
	Value.	Value.	Value.	Value.	Value.	Value.	Value.	Value.	Value.	Value.	Value.	Value.
March.....	\$1 22	\$1 38	.....	\$2 60	\$1 58	\$2 69	\$0 01	\$4 28	\$1 59	\$3 92	\$0 03	\$5 56
April.....	1 22	1 27	.....	2 49	1 58	2 69	.02	4 29	1 58	2 86	.03	4 51
May.....	61	1 52	\$ 01	2 45	1 20	2 70	.02	3 72	1 18	2 81	.07	4 10
June.....	61	1 23	.....	1 84	80	1 99	.03	2 82	1 79	2 79	.03	3 62
July.....	61	1 24	.06	1 91	80	1 93	.02	2 75	70	2 90	.02	3 71
August.....	61	1 07	.....	1 68	80	2 04	.....	2 83	78	2 67	.01	3 47
September.....	61	1 18	.....	1 79	80	2 01	.....	2 84	78	2 90	.01	3 71
October.....	92	2 38	.....	3 30	1 20	2 55	.01	3 76	1 16	3 64	.....	4 81
November.....	1 22	2 76	.....	3 98	1 58	3 19	.01	4 78	1 54	4 87	.01	6 41
December.....	1 22	2 85	.....	4 07	1 58	3 99	.02	5 59	1 53	5 54	.....	7 07
January.....	1 22	2 83	.....	4 05	1 58	4 54	.....	6 12	1 52	5 50	.01	7 04
February.....	1 22	2 83	.....	4 05	1 58	3 59	.01	5 18	1 52	4 44	.02	5 98
Winter Season.....	8 23	15 99	.....	24 22	10 68	23 53	.07	34 28	10 46	30 72	.12	41 41
Summer Season.....	3 37	6 55	.07	9 99	4 40	10 41	.09	14 90	4 30	14 12	.10	18 58
Yearly.....	11 60	22 54	.07	34 21	15 08	33 94	.16	49 18	14 76	44 84	.22	60 02

TABLE XIV.—CREDITS FOR PRODUCTS OTHER THAN MILK SOLD PER COW PER MONTH AT WEBBERVILLE.

The three bottom lines of the table show the credits for products other than milk for winter and summer seasons and the yearly total.

Year.	1916-17.				1917-18.			
Month.	Manure value.	Milk used on farm, value.	Milk returned from plant, value.	Total value.	Manure value.	Milk used on farm value.	Milk returned from plant, value.	Total value.
March.....	\$1 10	\$0 98	\$0000	\$2 08	\$1 50	\$1 12	\$0 0026	\$2 62
April.....	1 10	91	0021	2 01	1 50	1 19	.....	2 69
May.....	83	68	0031	1 51	1 12	82	003	1 94
June.....	55	61	0156	1 18	75	67	0398	1 46
July.....	55	63	0105	1 19	75	71	0470	1 51
August.....	55	76	0024	1 31	75	67	0111	1 43
September.....	55	96	0018	1 51	75	1 37	.....	2 12
October.....	83	1 55	0045	2 38	1 12	1 87	.....	2 99
November.....	1 10	1 45	0012	2 55	1 50	1 78	.....	3 28
December.....	1 10	1 30	.....	2 40	1 50	1 83	.....	3 33
January.....	1 10	1 54	.....	2 64	1 50	2 08	.....	3 58
February.....	1 10	1 01	.....	2 11	1 50	1 75	.....	3 25
Winter Season.....	\$7 43	\$8 34	\$0 0059	\$15 77	\$10 12	\$11 18	\$0 004	\$21 30
Summer Season.....	3 03	4 04	0353	7 11	4 12	4 68	100	8 90
Yearly.....	10 46	12 38	0412	22 88	14 24	15 86	104	30 20

TABLE XV.—COMPARISON OF MONTHLY MILK COSTS AND RECEIPTS, PER COW AND PER HUNDRED WEIGHT AT HOWELL.

The three bottom lines of the table show the comparison of milk costs and receipts for winter and summer seasons, and the yearly total.

Month.	1916-17.						1917-18.					
	Receipts from milk sold.	Net cost of milk sold.	Profit per cow.	Loss per cow.	Price received per cwt. for milk at plant.	Cost of milk sold per cwt.	Profit per cwt.	Loss per cwt.	Receipts from milk sold.	Net cost of milk sold.	Profit per cow.	Loss per cow.
March.....	\$9 54	\$13 69	.....	\$4 15	\$1 526	\$2 190	.....	\$664	\$12 31	\$13 87	.....	\$1 56
April.....	8 60	13 16	.....	4 56	1 440	2 204	.....	764	9 88	12 99	.....	3 11
May.....	7 75	10 19	.....	2 44	1 236	1 625	.....	389	11 08	10 69	.....	.....
June.....	6 28	7 85	.....	1 57	1 112	1 389	.....	277	10 63	8 65	1 98	.....
July.....	4 39	6 57	.....	2 18	1 224	1 830	.....	606	7 84	6 83	1 01	.....
August.....	3 65	6 34	.....	2 69	1 331	2 314	.....	983	5 24	5 82	.....	58
September.....	3 14	6 91	.....	3 77	1 447	3 184	.....	1 737	4 74	6 50	.....	1 76
October.....	5 25	7 65	.....	2 40	1 831	2 665	.....	1 834	8 28	10 30	.....	2 02
November.....	7 75	10 45	.....	2 70	2 004	2 700	.....	696	11 40	13 98	.....	2 58
December.....	10 21	12 02	.....	1 81	2 029	2 389	.....	360	16 85	17 66	.....	81
January.....	12 73	13 43	.....	70	2 091	2 205	.....	114	18 91	19 49	.....	58
February.....	11 93	12 35	.....	42	2 102	2 174	.....	072	16 79	17 77	.....	98
Winter season....	67 33	86 07	.....	18 74	1 798	2 298	.....	500	96 18	108 01	.....	11 83
Summer season..	23 89	34 54	.....	10 65	1 275	1 844	.....	569	37 77	36 54	1 23	.....
Yearly.....	91 22	120 61	.....	29 39	1 625	2 147	.....	524	133 95	144 55	.....	10 60

TABLE XVI.—COMPARISON OF MONTHLY MILK COSTS AND RECEIPTS, PER COW AND PER HUNDRED WEIGHT AT WEBBERVILLE.

The three bottom lines of the table show the comparison of milk costs and receipts for winter and summer seasons, and the yearly total.

Month.	1916-17.							
	Receipts from milk sold.	Net cost of milk sold.	Profit per cow.	Loss per cow.	Price received per cwt. for milk at plant.	Cost of milk sold per cwt.	Profit per cwt.	Loss per cwt.
March.....	\$9 90	\$12 43	.....	\$2 53	\$1 625	\$2 041	.....	\$0 416
April.....	7 93	10 39	.....	2 46	1 472	1 928	.....	456
May.....	7 63	7 57	\$0 06	.....	1 251	1 241	\$0 01	.....
June.....	5 89	6 42	.....	53	1 161	1 266	.....	105
July.....	4 68	5 36	.....	66	1 381	1 581	.....	200
August.....	4 01	4 55	.....	54	1 690	1 919	.....	229
September.....	3 80	4 72	.....	92	1 698	2 107	.....	409
October.....	5 59	5 98	.....	39	1 989	2 142	.....	153
November.....	7 43	8 08	.....	65	1 971	2 143	.....	172
December.....	9 43	10 38	.....	93	1 969	2 167	.....	198
January.....	12 08	11 71	37	.....	2 120	2 054	066	.....
February.....	11 18	11 66	.....	48	2 075	2 163	.....	088
Winter Season.....	\$65 68	\$70 10	.....	\$4 42	\$1 848	\$1 973	.....	\$0 125
Summer Season.....	23 87	29 14	.....	5 27	1 357	1 656	.....	299
Yearly.....	89 55	99 24	.....	9 69	1.686	1.868	.....	182

1917-18.								
March.....	\$12 09	\$13 20	.....	\$1 11	\$1 976	\$2 156	.....	\$0 180
April.....	10 69	12 66	.....	1 97	1 908	2 260	.....	352
May.....	10 42	9 72	\$0 70	.....	1 821	1 699	\$0 122	.....
June.....	9 23	8 26	97	.....	1 842	1 648	194	.....
July.....	6 59	7 60	.....	1 01	2 053	2 367	.....	314
August.....	4 84	6 37	.....	1 53	2 280	3 004	.....	724
September.....	5 25	6 30	.....	1 05	2 488	2 985	.....	497
October.....	8 53	8 27	26	.....	2 846	2 756	090	.....
November.....	10 97	12 70	.....	1 73	2 919	3 377	.....	458
December.....	14 91	16 80	.....	1 89	3 067	3 456	.....	389
January.....	17 34	18 36	.....	1 02	3 140	3 326	.....	186
February.....	16 83	17 73	.....	90	3 051	3 212	.....	161
Winter.....	\$93 12	\$101 88	.....	\$8 76	\$2 582	\$2 825	.....	\$0 243
Summer Season.....	34 57	36 09	.....	1 52	2 096	2 188	.....	092
Yearly.....	127 69	137 97	.....	10 28	2 430	2 626	.....	196

Tables XV and XVI give the cost of production and the amount received per cow and per hundred weight of milk for each month as well as for the winter and summer seasons and for each year of the entire period covered. There has been a steady increase in costs as well as in prices received during this period and the data given should be of great interest to the reader. It shows that in the Howell territory in March, 1916, it cost the farmer \$2.19 to produce one hundred pounds of milk for which he received \$1.526, thus making a net loss of \$0.664, while in February, 1919, the cost per hundred weight has risen to \$3.279 and the

price received was \$3.337. The cost increased 49% during the period given in the table, and out of the 36 months studied, only seven were profitable.

Figure IV shows the general trend of costs and prices received per hundred weight of milk during the period this study covers. The greatest spread between prices received and cost of production came during the September months when milk production was at its lowest point, thus making the cost per unit very high.

The average yearly loss per cow was \$29.39 the first year, \$10.60 the second year, and \$20.54 the third year.

Out of the twenty-five farms studied in this district only one made a profit the first year, nine the second, and six the third.

To have enabled all farmers to recover cost of production when selling milk at the prices named, a yearly average production of 8,088 pounds per cow would have been required. Furthermore, it would have been necessary to accomplish this larger production without any additional expenditure for extra feed.

In March, 1916, it cost the Webberville farmers \$2.041 per hundred-weight, and in February, 1918, \$3.212 or an increase of 57.4% in two years.

The average yearly loss per cow was \$9.69 the first year and \$10.28 the second year. Out of the twenty-five farms studied four made a profit the first year and nine the second year.

As a whole, milk was produced considerably cheaper at Webberville (figure V) than at Howell, which may be attributed to the smaller investment, the larger amount of cheap grain fed, and the fewer hours spent in caring for the dairy herd. However, the general trend of prices and costs was similar to that of Howell territory. (Figure IV.)

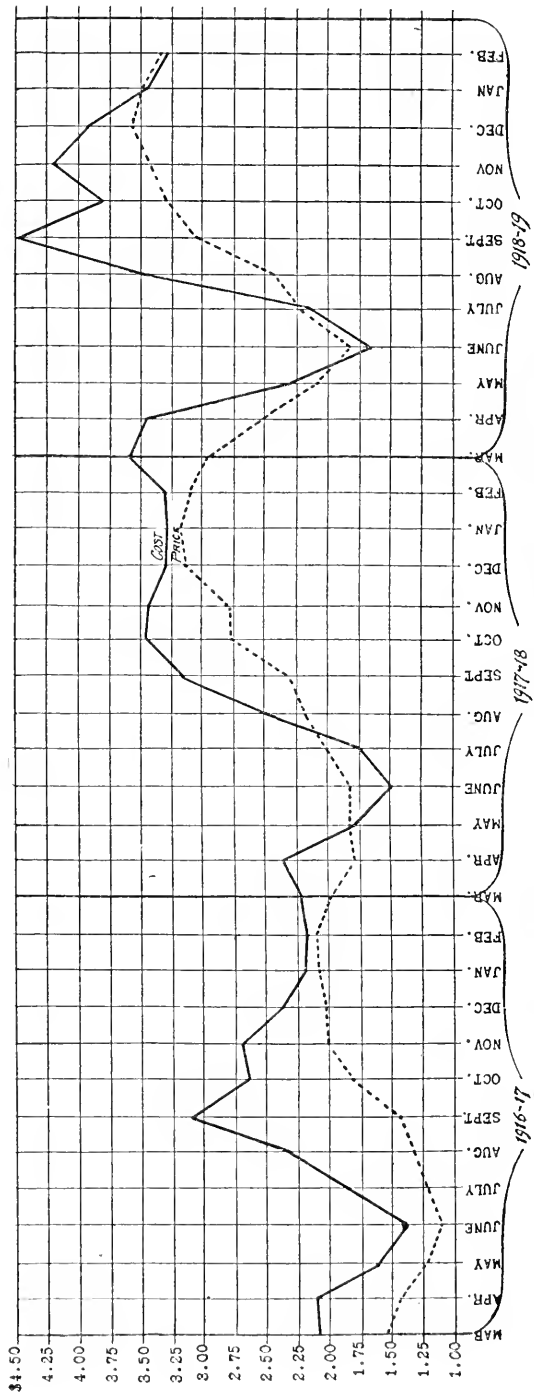


FIG. IV. AVERAGE COST OF PRODUCTION AND PRICE RECEIVED FOR MILK AT HOWELL.

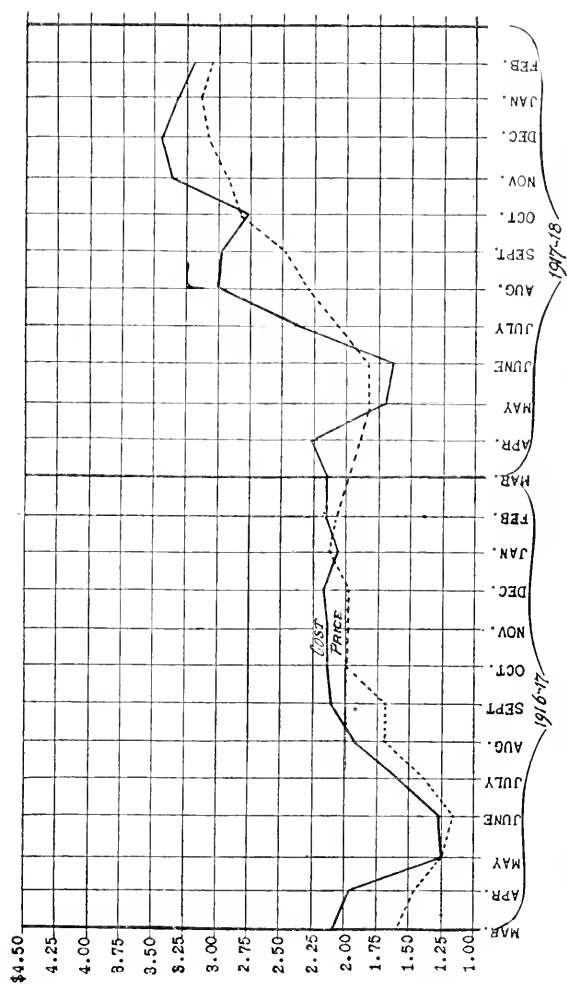


FIG. V., AVERAGE COST OF PRODUCTION AND PRICE RECEIVED FOR MILK AT WEBSVILLE.

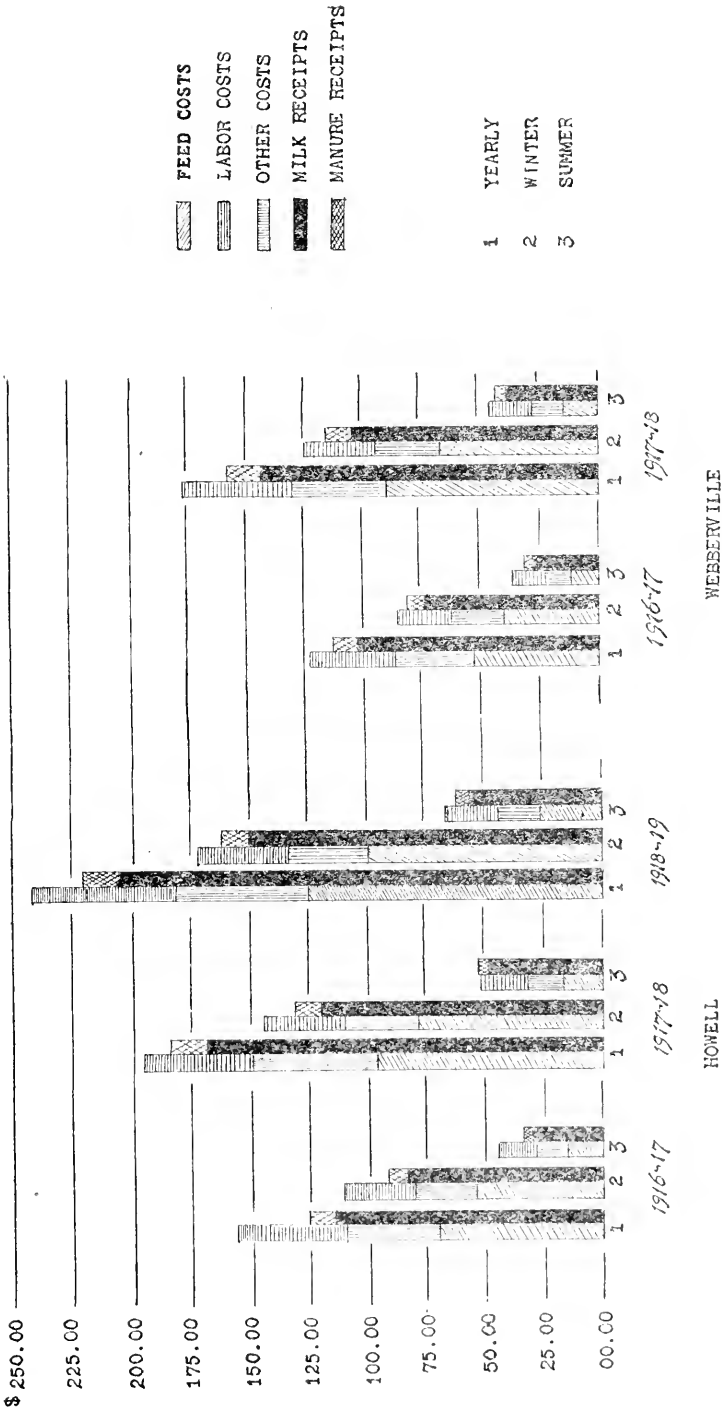


FIG. VI. AVERAGE EXPENDITURES AND RECEIPTS PER COW FOR EACH SEASON AND THE YEAR.

SUMMARY.

1. In order to keep a detailed record of the dairy costs it was necessary to separate the dairy business from the other farm operations. In this way the dairy is dependent entirely on its own resources.

2. As cost of milk production was the main factor under consideration in this Bulletin, the method used was based on the dairy cow as a unit.

3. The fields studied were located in the vicinity of Howell, Livingston county, and Webberville, Ingham county. Twenty-five farms were studied in each territory for a period of three years at Howell and two years at Webberville.

4. Of the total cost, feed represents 48.9%, labor 24.1%, and other costs 27.0% at Howell, and at Webberville, feed represents 46.4%, labor 25.2% and other costs 28.4%.

5. The average cost of keeping a cow was \$154.82 in 1916-17 and \$241.34 in 1918-19 at Howell, and at Webberville the cost amounted to \$122.12 the first year and \$168.17 the second year.

6. The total receipts per cow at Howell from all sources amounted to \$125.43 in 1916-17 and \$220.80 in 1918-19. At Webberville the total receipts amounted to \$112.43 in 1916-17 and \$157.89 in 1917-18.

7. The average annual production per cow was 7,211 pounds at Howell and 6,047 pounds at Webberville.

8. The average selling price per hundred weight for the Howell territory was \$1.625 the first year, \$2.405 the second year, and \$2.881 the third year. At Webberville the selling price was \$1.686 the first year and \$2.430 the second year.

9. It cost to produce every hundred pounds of milk sold at Howell \$2.147 in 1916-17, \$2.596 in 1917-18, and \$3.249 in 1918-19, and at Webberville in 1916-17 it cost \$1.868, and in 1917-18 the cost was \$2.626.

After reading the foregoing pages, the reader may wonder how any dairy farmer can produce and sell milk at the prevailing prices and still continue in the business.

In answering the query it must be conceded that many do quit the business or turn to other types of farming. In general it may be said that those farmers who continue in the business of producing milk for the city trade do so in conformity to some one or more of the following reasons:

First: In order to make their business balance they must credit to themselves for time spent with the dairy a much lower hourly wage than the hired laborer would or could accept. The average wage for all time spent in dairy operations on the farms reported in this Bulletin was a trifle less than 12½ cents per hour. The character of the work to be performed in producing milk is such that intelligent and willing help is essential. Such labor must be well paid, or if the work is performed by the farmer or members of his family, they must feel that the financial returns of the enterprise are such as to properly recompense them for their painstaking effort. Already large numbers of

farmers' sons are flocking to the cities to accept employment in the various factories and plants. Unless rural employers can in some measure successfully compete for the services of these men milk production will certainly be decreased.

Second: A second reason why the farmer may accept a very low hourly wage and still continue to carry on his business is that he works more hours per day than the standard laborer. Dairy cows could not be properly milked by maintaining a single crew of men on an eight hour schedule. The eight hour day can never come on the dairy farm. The dairyman's actual working time comes much nearer to 12 hours out of the 24 than it does to 10 hours.

In justice to the dairy business it must be said that fully one-sixth of the time spent in the dairy would be classed as over-time by the city laborer. By this we mean that it is performed on holidays or Sundays or very early in the morning or very late at night.

Third: In presenting the third reason it must be borne in mind that dairy farming and milk production is one of the most expensive types of farming; that is, it demands a much larger investment than grain or crop farming. A person without considerable capital may not undertake dairy production except as a tenant. Necessary land, buildings, cattle and special equipment compel the dairy farmer to have a comparatively large capital before he can enter upon the business of milk production.

If, as is often the case, the dairy farmer accepts less than the legal rate of interest on his investment or as is sometimes the case he receives no annual interest on his investments in land, cattle, buildings, and equipment, he may still continue the business.

It is self-evident, however, that dairy production must return a reasonable annual interest on the capital invested if it is to be a permanent agricultural enterprise.

Fourth: Many farmers continue to stay in the business by "mining" their farms. Cropping from year to year without adding an equal amount of fertilizer means that the operator is selling his farm by degrees and in time its actual value for dairy production is greatly lowered. In this same manner farmers stay in the business by wearing out their buildings and equipment and never replacing them.

Fifth: It must be conceded that there is some additional income besides the regular receipts from the dairy. While this is not large on the specialized dairy farm, it sometimes helps the farmer to break even or at least saves him from excessive loss.

THE DATA PRESENTED AS A FORMULA.

The data in this bulletin are more or less a record or history of the dairy business for the past three years and do not represent present conditions, due to the change which has taken place in prices. For this reason the following formula has been designed for the purpose of making this data applicable to all conditions, and by applying current prices to the amounts of feed and labor given, the portion of the cost of milk represented by these factors should be approximately correct. While this formula only gives the feed and labor items, the other items which cannot be represented in terms of pounds or days are consequently represented by a corrective factor, which means a factor stated in percentages of feed and labor. For example, the corrective factor for the winter feeding period is .2183 or 21.83% of the feed and labor costs. This corrective factor has been adjusted so as to take care of the receipts such as manure, etc., and the total gives the net cost of producing 100 pounds of milk. If the feed and labor costs, including the hauling of milk amount to \$3.25, then \$3.25 multiplied by .2183 equals \$0.71. \$3.25 plus \$0.71 equals \$3.96, the net cost of 100 pounds of milk. The same application holds true for all the seasons and the year.

A FEED AND LABOR FORMULA.

The following formula give the average feed and labor items and their amounts, entering into the production of 100 pounds of milk at Howell and Webberville for each season and the year. The other costs (overhead) are determined by multiplying the value of these items by the corrective factors given, thus giving the approximate net cost of producing milk.

Seasons.	Winter Period.	Summer Period.	Yearly.
Home grown grains.....	12.1 lbs.	4.0 lbs.	9.4 lbs.
Commercial feeds.....	16.5 lbs.	6.8 lbs.	13.3 lbs.
Hay.....	49.2 lbs.	10.5 lbs.	36.3 lbs.
Other dry roughage.....	21.4 lbs.	2.5 lbs.	15.1 lbs.
Silage.....	147.2 lbs.	21.1 lbs.	105.1 lbs.
Solling crops and other succulent feeds.....	3.5 lbs.	9.6 lbs.	5.5 lbs.
Pasture days.....	17.9 lbs.	2.9 lbs.	12.9 lbs.
Bedding.....	1.01 hrs.	.96 hrs.	.99 hrs.
Labor performed by owner or operator.....	.99 hrs.	1.00 hrs.	1.00 hrs.
Labor performed by hired help.....	.11 hrs.	.05 hrs.	.09 hrs.
Hauling milk, cost per cwt.....			
Corrective factor.....	.2183	.4499	.2750

ACKNOWLEDGMENTS.

Due credit should be given the following men who devoted their time to the collection of the statistics presented in this Bulletin: Mr. A. C. Lytle who collected all the Webberville data, and to Messrs. Stanley J. Brownell, H. A. Andrews, and Ray Baker who collected the Howell data.

The authors also wish to express their appreciation to the farmers who co-operated with the field accountants by allowing records to be secured on their farms, and for their assistance in furnishing information which made it possible to secure the statistics given in the following pages.

FERTILIZER ANALYSES

Bulletin No. 237.

The inspection and analysis of commercial fertilizer, sold, offered or exposed for sale in Michigan is made under authority of an act of the Legislature approved March 10, 1885, and as amended during the session of 1913. The full text of the law will be sent to any person upon request.

LICENSED BRANDS.

During the year 1919, 40 manufacturers and fertilizer companies licensed 374 brands for sale in the State. This is the largest number of brands ever licensed in one year. Attention is called to the fact that the fertilizer law covers only those materials which are sold, offered or exposed for sale within the State, the retail price of which is \$10.00 or more per ton. Manufacturers residing outside the State may ship direct to the consumer without paying the license fee but the party making the purchase receives no protection under the law. If the sale of fertilizer to be shipped direct to the consumer is made by an agent or representative of the manufacturer while in the State, the act is considered as one of actually offering the material itself for sale, and the fertilizer then becomes subject to the requirements of the law just as surely as though the fertilizer were actually brought into the State and then sold. Consequently, an agent of a fertilizer company is technically violating the law when he solicits or accepts orders for any unlicensed fertilizer, while in the State.

COLLECTION OF SAMPLES.

The collection of samples was made during the spring and fall shipping seasons by inspectors appointed by the State Board of Agriculture.

All sections of the State in which fertilizers are used to any extent were visited and 1,083 samples were secured from stocks being offered for sale by dealers. For this purpose a specially constructed tube is used which permits of securing a core from the entire length of the bag. An official sample consists of the cores taken from not less than five separate sacks of the same brand. The five or more separate cores are mixed together, placed in a stout sack, tied, sealed and forwarded to the laboratory for analysis.

Much of the fertilizer used in the State is taken directly from the cars by the consumers and it is never possible for the inspectors to secure samples of all the brands registered. It sometimes happens that a manufacturer fails, for some reason or other, to sell any of a particular brand or the sales may be very light and in the latter case it is only by chance that a sample is found.

During the past year, 23 registered brands were not shipped into the State. It was formerly the custom, whenever we failed to find a brand

on the market, to analyze the sample forwarded by the manufacturer, as required by law, at the time of applying for the license. It has long been known that these samples were generally if not always made up in the laboratories of the companies and were not, therefore, representative of the product as put on the market. For this and other reasons we have discontinued this practice and in this bulletin the brands not represented by samples are listed in their proper places but are not given a laboratory number and only the guaranteed analysis is shown.

In many cases several samples of the same brand were drawn and analyzed. This, of course, greatly increases the work in the laboratory but it is the only way by which we can ascertain if the brands are running uniform. If only one sample were analyzed, or if several samples were taken and composited before being analyzed, variations in the composition would not be detected.

ANALYSIS OF MISCELLANEOUS SAMPLES.

On account of the large amount of work involved in the inspection of fertilizers our laboratory force is kept busy constantly with samples collected by the inspectors. It is therefore impossible for us to give attention to miscellaneous fertilizer samples sent to us. Furthermore, unless the samples are taken in the manner previously described they will not truly represent the lot or shipment of which they were a part and the analysis of such a sample would be an injustice either to the manufacturer or purchaser.

In all cases where doubt arises as to the merits of any particular shipment, we suggest that this office be notified and an inspector will be sent to make an investigation and draw an official sample.

RESULTS OF INSPECTION.

A study of the tables of analyses show that, of the 1,083 samples analyzed, representing 342 brands, 267 (24.7%) are below guarantee* in one or more constituent. Seventy-seven (7.1%) are below guarantee in nitrogen, 9 (0.8%) are below guarantee in total phosphoric acid, 98 (9.0%) are below in available phosphoric acid and 142 (13.1%) in potash.

In making a careful study of the tables of analyses it will be noted that the majority of deficiencies are confined to a comparatively few companies. For example one company contributes 26 per cent of all the brands found below guarantee, three companies contribute 49 per cent of the deficient brands and eight companies contribute 75 per cent of the brands showing deficiencies. In other words, 20 per cent of the manufacturers are responsible for three-fourths of all the deficiencies.

It is not claimed that these deficiencies are the result of wilful attempts to defraud the purchasers, in fact, we believe this is not the case, but the fact remains nevertheless, that a few companies are responsible for the majority of the deficiencies and whether these result from pre-meditated plans or from poor factory management the results are the same and the purchaser must suffer the loss.

*A shortage of more than 0.10 per cent of nitrogen or more than 0.20 per cent available phosphoric acid or more than 0.10 per cent potash is considered below guarantee.

In a few instances the deficiencies noted are plainly due to an error on the part of workmen in the factory, such as filling bags from the wrong pile. These, of course, are excusable and should be overlooked. But where every sample of some particular brand is found to be below guarantee, not only in one ingredient but in two and sometimes all three ingredients the deficiencies cannot be charged up to mistakes of workmen. Such a condition can only be explained on the grounds of poor factory management or to a desire on the part of the company to mix so close to the formula as to avoid overrun as much as possible.

A summary of the inspection is given in the following table.

Manufacturer.	Number of brands licensed.	Number of samples analyzed.	Number below guarantee in one or more ingredient.	Percentage of total number of deficiencies.
American Agricultural Chemical Co.	88	285	10	3.7
Armour Fertilizer Works.	28	84	29	10.9
The Barrett Co.	1	2	1	0.4
R. Binder Co.	1	1	1	0.4
N. Burleson.	1	2	1	0.4
E. Burton Fertilizer Works.	1	1	0	0.0
Calumet Fertilizer Co.	19	56	16	6.0
Chicago Feed & Fertilizer Co.	1	1	0	0.0
Cincinnati Plant Food Co.	1	1	0	0.0
Columbia Guano Co.	9	11	5	1.9
Darling & Co.	11	45	12	4.5
Federal Chemical Co.	30	65	19	7.1
Fertile Chemical Co.	2	2	0	0.0
Gleaner Clearing House Association.	8	10	2	0.8
Holland-St. Louis Sugar Co.	2	2	0	0.0
Independent Packers Fertilizer Co.	10	36	11	4.1
International Agricultural Corporation.	13	48	3	1.1
Jarecki Chemical Co.	12	28	12	4.5
Morris & Co.	12	52	11	4.1
National Plant Food Co.	8	1	1	0.4
Natural Guano Co.	1	2	0	0.0
Nitrate Agencies Co.	1	1	0	0.0
Pacific Manure & Fertilizer Co.	1	0	0	0.0
Packers Fertilizer Co.	1	3	1	0.4
Parke Davis & Co.	12	34	9	3.4
Pulverized Manure Co.	1	0	0	0.0
Queen City Fertilizer Co.	3	4	2	0.8
F. S. Royster Guano Co.	1	1	1	0.4
Smith Agricultural Chemical Co.	21	113	70	26.2
Sodus Humus Co.	7	22	2	0.8
Solvay Process Co.	1	1	1	0.4
L. Speidel.	1	1	0	0.0
J. L. & H. Stadler Rendering & Fertilizer Co.	1	2	1	0.4
Nicholas Swartz.	11	22	0	0.0
Swift & Co.	1	1	0	0.0
Virginia Carolina Chemical Co.	24	86	32	12.0
Wayne Soap Co.	19	42	7	2.6
Thos. W. Wolcott.	2	1	1	0.4
Wuichet Fertilizer Co.	1	1	1	0.4
	6	13	5	1.9
	374	1,083	267	100.4

FERTILIZER STATISTICS.

The following table shows the amount of fertilizer used in the State for three years 1913, 1917 and 1919, as determined from the sales reported by the manufacturers. It will be noted that in the seven years, from 1913 to 1919 inclusive, there was an increase of 107 per cent. The greatest increase took place in 1917 and prior thereto, as in the past two years the increase has been a little less than 13 per cent.

Year.	Spring tonnage.	Fall tonnage.	Total tonnage.
1913.....	28,166	21,612	49,808
1917.....	46,369	45,086	91,455
1919.....	52,582	50,682	103,264

HIGH GRADE FERTILIZERS MOST ECONOMICAL.

Since the outbreak of the great war there has been a very great change in the character of the fertilizers offered for sale in the State. Previous to that time brands containing 2 per cent ammonia, 8 per cent available phosphoric acid and 5 to 10 per cent potash were very common. However with the beginning of hostilities importation of potash salts ceased and in order to conserve the supply then on hand the percentage supplied in fertilizers was reduced to 3 per cent as the maximum and in many brands it was eliminated entirely. During this time the cost of the potash advanced from \$1.00 per unit to \$8.00 or more as the upper limit. This began to stimulate local production of potash and the price has gradually receded to \$3.00 per unit. At the same time the demand for nitrate of soda for the manufacture of war munitions and sulfate of ammonia for refrigeration purposes caused the price of ammoniates to advance to a point more than double the former price.

This scarcity of ammoniates and potash and the desire of the manufacturers to meet the popular demand for lower-priced fertilizers has been responsible for the appearance of several brands containing only one-half per cent of ammonia and potash respectively with varying amounts of phosphoric acid.

All this time the cost of manufacturing fertilizers has been steadily increasing owing to increased wages, freight rates, cost of bags, etc. Consequently, by cheapening the quality of the fertilizers with a corresponding lowering of the price per ton, the actual cost of the plant-food has been increased.

For example, suppose a farmer were planning to use 4 tons of a 1½-8-1½ fertilizer on oats in the spring. The manufacturer's price of this brand is \$30.25 to which should be added about \$2.50 per ton as the dealers profit. The total cost of the 4 tons would therefore be \$131.00. The same amount of plant-food could be obtained in one ton of a 2-12-2 fertilizer and one ton of 20% acid phosphate which would cost \$47.00 and

\$31.25 respectively plus \$2.50 per ton as the dealers profit, or a total of \$83.25. The saving, therefore, in using the two tons of high grade fertilizers would be \$47.75. In addition there would be the saving in the cost of handling only two tons of fertilizer instead of 4 tons. This alone, would pay for the cost of mixing the 2-12-2 fertilizer with the acid phosphate.

This saving is effected principally by a reduction in the overhead expense for it costs just as much to mix one ton of the $\frac{1}{2}$ -8- $\frac{1}{2}$ fertilizer as one ton of the 2-12-2 fertilizer. A tremendous saving could, therefore, be effected if the farmers would purchase their plant-food in the higher analysis fertilizers. It has already been stated that 103,264 tons of fertilizer were used in Michigan during 1919. This amount could, unquestionably, be reduced by 25,000 tons without reducing the amount of actual plant-food if the farmers would buy only high-grade fertilizers. This would mean a saving of more than \$450,000. During the past two years there has been considerable agitation from various sources, toward the use of higher grade fertilizers, but very little will be accomplished along this line until the farmers themselves demand such fertilizers.

In the following table is shown a list of fertilizer formulas varying from very low to high-grade with the manufacturers price and the percentage of this required to cover the overhead expense.

Formula.	Wholesale price.	Per cent required for overhead.
$\frac{1}{2}$ - 8- $\frac{1}{2}$	\$30 25	62
1-10-0.....	33 50	56
1- 8-1.....	34 75	54
0-12-2.....	35 25	53
1- 9-1.....	35 75	52
1-10-1.....	36 50	51
1- 8-2.....	37 75	50
2-10-0.....	39 50	47
2- 8-1.....	40 50	46
2-12-0.....	41 25	45
2- 8-2.....	43 50	43
3- 8-1.....	46 50	40
2-12-2.....	47 00	40
2-12-3.....	50 00	38
2- 8-5.....	52 25	36

It will be noted that with the low grade ($\frac{1}{2}$ -8- $\frac{1}{2}$) formula, the overhead expense constitutes 62 per cent of the wholesale price while with the high-grade (2-8-5) the overhead constitutes only 36 per cent of the purchase price. As the actual value of the fertilizer increases the lower becomes the overhead percentage. In other words, with the low grade fertilizers the overhead or manufacturing cost is more than the plant-food itself is worth while with the higher grades the value of the plant-food is considerably more than the overhead expense. In purchasing fertilizers, therefore, it should be the aim of the buyer to secure just as much of the desired forms of plant-food per ton of fertilizer as possible and reduce the per acre application to comply with previous practice. For example, it would be much more economical to use 100 lbs. of 20% acid phosphate or 125 lbs. of 16% acid phosphate per acre than 200 lbs. of 10% acid phosphate, as the following figures will show:

200 lbs. 10% Acid Phosphate costs	\$4.75
100 lbs. 20% Acid Phosphate costs	3.12
<hr/>	
Saving per acre	\$1.63
200 lbs. 10% Acid Phosphate costs	\$4.75
125 lbs. 16% Acid Phosphate costs	3.54
<hr/>	
Saving per acre	\$1.21

Exactly the same amount of available phosphoric acid is contained in 100 lbs. of 20% acid phosphate or 125 lbs. of 16% acid phosphate as in 200 lbs. of 10% acid phosphate and the saving in one case is \$1.63 and in the other \$1.21. Still some farmers continue to use 10% acid phosphate because it is cheaper per ton.

In these times when labor is scarce and very expensive the farmers should endeavor to produce the maximum amount per acre. The judicious use of fertilizers will help toward this end and careful buying will have much to do with the amount of profit derived from the use of fertilizers.

EXPLANATION OF TABLES.

The results of analysis shown in the following tables are arranged by manufacturers, in alphabetical order. Those found below guarantee are printed in bold-face type.

Nitrogen. It will be noted that the results under this heading are divided into four columns. The column headed "As Soluble" shows the amount of nitrogen that is soluble in water. This would include all nitrogen present as nitrate of soda, sulfate of ammonia, cyanimid, etc. This portion of the nitrogen is considered to be immediately available.

The second and third columns together represent the nitrogen that is insoluble in water. This insoluble nitrogen is separated into "active" and "inactive" nitrogen depending upon its reaction with an alkaline solution of potassium permanganate. When the amount shown "as active insoluble organic" is greater than that shown "as inactive insoluble organic" the whole insoluble nitrogen is considered to be of good quality. In other words, it has been derived from some high-grade material possessing a high rate of availability or the material used has been treated in such manner as to render it largely available. If, on the other hand, the amount of nitrogen shown in the "inactive" column is greater than that shown in the "active" column then the *insoluble nitrogen* is considered to be low grade with a low rate of availability. When the insoluble nitrogen constitutes a small percentage of the total, its rate of availability would, of course, be of small consequence. But, where the "insoluble nitrogen" constitutes a considerable portion of the total, as is very often the case, then, its rate of availability is an important factor.

Since nitrogen is, by far, the most expensive plant-food ingredient in fertilizers, more attention should be given to the results printed in the following pages under this heading and when purchasing nitrogenous fertilizers preference should be given those companies that show the

insoluble nitrogen in their mixtures to be derived from high-grade materials.

The fourth column shows the total amount of nitrogen in the sample. It is equal to the sum of the first three columns.

Phosphoric Acid. Three divisions are included under this heading, designated as "total," "insoluble" and "available." The "total" phosphoric acid includes all of this ingredient in the sample. The "insoluble" phosphoric acid represents that portion that is unavailable and the "available" phosphoric acid, is, as the name implies, readily available. The available phosphoric acid represents the difference between the total and insoluble phosphoric acid.

Potash. The results shown under this heading are those soluble in water as required by the law. Water-soluble potash is, of course, readily available.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Insoluble.	Available.	
A 2841 A 2862 A 3067 A 3508	American Agricultural Chemical Co., Detroit Mich.	Plymouth.....	{ G.† F.†	0.37	0.32	1.65	15.35	1.02	12.00
		Beech.....	1.00	0.41	0.36	1.71	14.53	1.02	14.53
		Buchanan.....	1.18	0.37	0.81	1.80	15.50	0.92	14.58
		St. Johns.....	1.10	0.42	0.23	1.81	15.60	1.02	14.58
		Average.....	1.08	0.39	0.30	1.75	15.30	1.64	13.66
						1.77	15.44	1.15	14.29
A 3252 A 3320	Beet Fertilizer 1916.....	Monroe.....	{ G.† F.†	0.39	0.32	0.82	10.45	0.74	9.00
		Birch Run.....	0.42	0.20	0.31	0.94	10.45	1.69	1.16
		Average.....	0.41	0.21	0.32	0.94	10.45	1.22	1.18
									1.00
A 3354 A 3383	Crown Phosphate and Potash.....	Davidson.....	{ G.† F.†			13.45	13.45	0.50	1.00
		Saginaw.....				13.82	13.82	0.82	0.68
		Average.....				13.64	13.64	0.66	0.84
A 155* A 2818 A 3229 A 3263	Favorite Potash Fertilizer.....	Mason.....	{ G.† F.†	0.63	0.14	0.82	10.65	1.36	8.00
		Traverse City.....	0.55	0.26	0.33	0.94	10.70	1.46	9.29
		Adrian.....	0.62	0.11	0.10	0.83	9.95	0.46	9.24
		St. Clair.....	0.52	0.24	0.24	1.00	10.90	1.56	2.12
		Average.....	0.53	0.19	0.21	0.95	10.55	1.21	2.08
									1.81
A 1985 A 2843 A 3066 A 3453	Fine Ground Bone.....	Grand Rapids.....	{ G.† F.†	0.52	1.03	1.65	27.00		1.88
		Plymouth.....	0.52	1.00	0.64	2.19	27.50		
		South Haven.....	0.47	0.84	0.47	1.97	30.40		
		Coopersville.....	0.49	0.83	0.49	1.78	29.90		
		Average.....	0.50	0.93	0.51	1.81	30.40		
						1.94	29.55		
A 3405 A 119*	Michigan Bean Grower 1916.....	Ithaca.....	{ G.† F.†	0.98	0.42	1.65	11.20	1.38	8.00
		Imlay City.....	0.53	0.19	0.29	0.82	10.50	1.12	8.00
	M. & I. 3% Potash Fertilizer.....					1.01			2.80

A 165*	M. & I. 3 ^c Potash Fertilizer.....	Union City.....	0.63	0.12	0.25	1.00	10.40	0.90	9.50	3.11
A 1984	M. & I. 3 ^c Potash Fertilizer.....	Grand Rapids.....	0.28	0.25	0.44	0.97	10.25	1.10	9.15	3.26
A 3154	M. & I. 3 ^c Potash Fertilizer.....	Covett.....	0.39	0.18	0.30	0.87	10.35	1.26	9.09	2.95
A 3246	M. & I. 3 ^c Potash Fertilizer.....	Mason.....	0.40	0.19	0.36	0.95	10.43	1.22	9.21	3.07
A 3390*	M. & I. 3 ^c Potash Fertilizer.....	Highland.....	0.55	0.14	0.32	1.01	10.65	1.02	9.63	2.90
	Average.....	Average.....	0.40	0.15	0.33	0.97	10.43	1.10	9.33	3.02
A 2724	New York State Special 1916.....	Bankers.....	{ G.†			0.82			8.00	1.00
A 2778	New York State Special 1916.....	Adrian.....	{ F.†	0.19	0.30	0.95	10.90	1.56	9.34	1.31
A 2795	New York State Special 1916.....	Free.....	0.35	0.28	0.38	1.01	11.05	1.04	10.01	1.23
A 2812	New York State Special 1916.....	Plymouth.....	0.41	0.19	0.34	0.91	10.70	0.80	9.90	1.18
A 2812	New York State Special 1916.....	Flat Rock.....	0.31	0.21	0.39	0.91	10.85	1.04	9.81	1.16
A 2904	New York State Special 1916.....	Adrian.....	0.46	0.20	0.32	0.98	10.70	1.32	9.38	1.18
A 3048*	New York State Special 1916.....	Adrian.....	0.71	0.13	0.16	1.00	10.50	1.06	9.44	1.10
	Average.....	Average.....	0.45	0.20	0.31	0.96	10.78	1.14	9.61	1.19
A 3004	Nitrate of Soda.....	Fennville.....	{ G.†			15.00				
A 3213	Nitrate of Soda.....	Detroit.....	{ F.†			15.83				
	Average.....	Average.....				15.77				
A 2668	1 & 10 Compound.....	Romeo.....	{ G.†	0.23	0.23	0.82	12.90	1.92	10.00	
A 2734	1 & 10 Compound.....	Osseo.....	{ F.†	0.59	0.29	1.05	13.00	1.80	11.20	
A 2840	1 & 10 Compound.....	Plymouth.....	0.56	0.19	0.29	1.04	13.00	1.46	11.84	
A 2860	1 & 10 Compound.....	Beech.....	0.49	0.22	0.27	0.98	13.30	1.60	12.10	
A 2863	1 & 10 Compound.....	Novi.....	0.42	0.25	0.33	1.00	13.70	1.86	11.39	
A 2895	1 & 10 Compound.....	Willow.....	0.47	0.14	0.30	0.91	13.25	1.56	12.04	
A 2903	1 & 10 Compound.....	Flat Rock.....	0.50	0.21	0.27	0.98	13.80	1.76	12.05	
A 3010	1 & 10 Compound.....	Hudsonville.....	0.56	0.23	0.29	1.08	13.65	1.60	12.65	
	Average.....	Average.....	0.59	0.22	0.24	1.05	13.40	1.92	11.48	
	Bradley Brands.									
A 3380	Acid Phosphate.....	Snover.....	{ G.†	0.52	0.21	0.28	13.38	1.74	11.64	
			{ F.†						10.00	
A 2817	16 ^c Acid Phosphate.....	Traverse City.....	{ G.†				12.70	1.22	11.48	
A 2928	16 ^c Acid Phosphate.....	Milan.....	{ F.†				18.85	0.86	16.00	
A 3066	16 ^c Acid Phosphate.....	Buchanan.....	{ F.†				18.25	0.76	17.99	
							18.55	0.64	17.91	
	Average.....	Average.....					18.55	0.75	17.80	
A 3151	All Crops Fertilizer.....	Lacota.....	{ G.†			0.82			10.00	1.00
			{ F.†	0.51	0.26	0.95	12.90	1.32	11.58	1.24
A 2819	B. D. Sea Fowl Guano 1918.....	Traverse City.....	{ G.†			1.65	10.50	1.92	8.00	
A 3065	B. D. Sea Fowl Guano 1918.....	Buchanan.....	{ F.†	1.02	0.47	1.85	10.35	1.72	8.63	
A 3152	B. D. Sea Fowl Guano 1918.....	Lacota.....	{ F.†	1.02	0.29	1.76	10.65	1.70	9.55	
			0.82	0.55	0.36	1.73				
	Average.....	Average.....	0.95	0.49	0.34	1.78	10.50	1.58	8.92	

†Abbreviations for Guaranteed and Found
•Fall Samples.

A 3123 A 3434	Ammoniated Wheat & Corn Phosphate No. 2 Ammoniated Wheat & Corn Phosphate No. 2	Muir. Coral.	{ G.† F.†	1.10 1.03	0.48 0.49	0.29 0.31	1.85 1.83	10.60 11.35	2.30 2.86	8.60 8.69	.....
A 3433	Bean Grower.....	Average.....	.....	1.06	0.49	0.30	1.85	11.08	2.58	8.50	.....
A 2901 A 3108	Complete Fertilizer. Complete Fertilizer.	Shepherd.	{ G.† F.†	1.00	0.35	0.32	1.65 1.67	10.30	1.20	8.00 9.10	1.00 1.11
A 3218 A 3294	Dissolved Bone Phosphate. Dissolved Bone Phosphate.	Batavia. Eaton Rapids.	{ G.† F.†	0.50 0.50	0.16 0.20	0.35 0.31	0.82 1.01 1.01	13.03 13.35	1.76 1.42	10.60 11.27 12.13	1.00 1.42 1.19
A 2881 A 2951 A 3219	General Crop Phosphate. General Crop Phosphate. General Crop Phosphate.	Average.....	.....	0.50	0.18	0.33	1.01	13.29	1.39	11.70	1.31
A 2994 A 2861 A 2876	High Grade Phosphate. High Grade Phosphate. High Grade Phosphate.	Monroe. Yale.	{ G.† F.†	.....	.....	.....	.....	15.90 16.00	0.48 0.76	14.00 15.42 15.21	.....
A 2994 A 2861 A 2876	High Grade Phosphate. High Grade Phosphate. High Grade Phosphate.	Average.....	.....	.....	.....	.....	.....	15.95	0.62	15.33	.....
A 3197 A 3261	New Rival Ammoniated Superphosphate 1916. New Rival Ammoniated Superphosphate 1916.	New Boston. Carleton. Monroe.	{ G.† F.†	0.37 0.27 0.36	0.24 0.27 0.22	0.34 0.40 0.36	0.82 0.95 0.94	9.60 9.85 9.30	1.26 1.62 1.20	7.00 8.34 8.23 8.10	1.00 1.14 1.17 1.06
A 3404	Sugar Beet Fertilizer.....	Average.....	.....	0.34	0.24	0.36	0.94	9.58	1.36	8.22	1.12
A 154* A 3124 A 3343	Universal Grain Grower 1916. Universal Grain Grower 1916. Universal Grain Grower 1916.	Batavia. Beech. Romulus.	{ G.† F.†	.....	.....	.....	.....	18.13 19.20 18.75	0.78 0.70 0.90	16.00 17.35 18.50 17.85	.....
A 3197 A 3261	New Rival Ammoniated Superphosphate 1916. New Rival Ammoniated Superphosphate 1916.	Average.....	.....	.....	.....	.....	.....	18.69	0.79	17.90	.....
A 3404	Sugar Beet Fertilizer.....	Eaton Rapids. Frazer.	{ G.† F.†	0.48 0.49	0.17 0.23	0.22 0.30	0.82 0.87 1.02	10.85 10.90	1.06 1.32	9.00 9.79 9.58	1.00 1.11 1.16
A 154* A 3124 A 3343	Universal Grain Grower 1916. Universal Grain Grower 1916. Universal Grain Grower 1916.	Average.....	.....	0.49	0.20	0.26	0.95	10.88	1.19	9.69	1.14
A 3404	Sugar Beet Fertilizer.....	Ithaca.	{ G.† F.†	0.65	0.17	0.32	0.82 1.14	12.25	1.14	9.00 11.11	1.00 1.16
A 154* A 3124 A 3343	Universal Grain Grower 1916. Universal Grain Grower 1916. Universal Grain Grower 1916.	Average.....	.....	0.52	0.20	0.25	0.97	11.22	1.59	9.63	1.12

†Abbreviations for Guaranteed and Found.
*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Insoluble.	Available.	
Michigan Carbon Works Brands.									
A 1906	A 1 Potash Fertilizer 1916.	Grand Rapids.				0.82	10.40	8.00	1.00
A 2663	A 1 Potash Fertilizer 1916.	Almont.	0.53	0.15	0.31	1.02	10.40	8.98	1.14
A 2665	A 1 Potash Fertilizer 1916.	Romney.	0.41	0.23	0.30	0.94	11.25	1.34	9.91
A 2697	A 1 Potash Fertilizer 1916.	Quincy.	0.36	0.25	0.37	0.98	10.85	1.40	9.45
A 2710	A 1 Potash Fertilizer 1916.	Reading.	0.41	0.19	0.27	0.87	10.08	0.90	9.18
A 2731	A 1 Potash Fertilizer 1916.	Osseo.	0.44	0.19	0.32	0.95	10.58	1.40	9.18
A 2853	A 1 Potash Fertilizer 1916.	Elm.	0.35	0.17	0.31	0.83	10.73	0.82	9.91
A 2874	A 1 Potash Fertilizer 1916.	Elm.	0.40	0.19	0.29	0.88	11.05	1.20	9.85
A 2882	A 1 Potash Fertilizer 1916.	Romulus.	0.47	0.17	0.22	0.86	10.20	0.92	9.28
A 2913	A 1 Potash Fertilizer 1916.	New Boston.	0.31	0.22	0.37	0.90	10.65	1.46	9.49
A 3127	A 1 Potash Fertilizer 1916.	Inkster.	0.51	0.19	0.27	0.97	11.15	1.36	9.79
A 3400*	A 1 Potash Fertilizer 1916.	Middleton.	0.39	0.20	0.25	0.84	11.30	1.22	10.08
A 3454*	A 1 Potash Fertilizer 1916.	Port Huron.	0.39	0.24	0.32	0.95	10.70	1.04	9.66
		Coopersville.	0.49	0.16	0.28	0.93	12.73	1.02	11.71
		Average.	0.42	0.20	0.30	0.92	10.92	1.19	9.73
A 1902	New Standard Fertilizer.	Coopersville.				0.82	10.92	10.00	1.12
A 2661	New Standard Fertilizer.	Almont.	0.49	0.24	0.31	1.04	11.61	2.10	9.51
A 2664	New Standard Fertilizer.	Romney.	0.65	0.23	0.22	1.10	13.55	1.94	11.61
A 2696	New Standard Fertilizer.	Quincy.	0.56	0.23	0.26	1.05	13.45	1.92	11.53
A 2702	New Standard Fertilizer.	Jonesville.	0.34	0.26	0.33	0.93	12.05	1.84	11.14
A 2879	New Standard Fertilizer.	New Boston.	0.23	0.28	0.32	0.83	12.58	1.76	10.82
A 2892	New Standard Fertilizer.	Waltz.	0.59	0.21	0.27	1.07	13.80	1.44	12.36
A 2894	New Standard Fertilizer.	Waltz.	0.46	0.20	0.28	0.94	12.80	1.46	11.34
A 3009	New Standard Fertilizer.	South Haven.	0.52	0.26	0.27	1.05	12.80	1.62	11.18
A 3309*	New Standard Fertilizer.	Port Huron.	0.72	0.24	0.25	1.11	12.60	1.62	10.98
			0.42	0.23	0.29	0.94	13.70	1.80	11.90
		Average.	0.50	0.23	0.28	1.01	12.59	1.75	11.24
A 1989	Red Line Complete Manure.	Coopersville.				0.82	8.90	7.00	1.00
A 3085	Red Line Complete Manure.	Zeland.	0.36	0.26	0.36	0.98	9.55	1.16	1.74
A 3449*	Red Line Complete Manure.	Coopersville.	0.33	0.26	0.31	0.93	10.13	1.10	8.45
			0.73	0.20	0.15	1.08	10.13	1.22	8.91
		Average.	0.47	0.24	0.28	0.99	9.53	1.16	8.37
									1.19

A 1991 A 2980 A 3083 A 3450*	Red Line Phosphate..... Red Line Phosphate..... Red Line Phosphate..... Red Line Phosphate.....	Coopersville..... New Boston..... Jamestown..... Coopersville..... Average.....	{ G.† { F.†	..... ..... ..... ..... .....	..... ..... ..... ..... .....	15.45 14.91 16.20 16.70 16.10 16.11	0.54 0.54 0.76 0.68 0.92 0.72	14.00 14.91 15.44 16.02 15.18 15.39
A 1983 A 1990 A 1997 A 2602 A 2711 A 2730 A 2896 A 2914 A 3005 A 3452*	Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate..... Superior Acid Phosphate.....	Grand Rapids..... Coopersville..... Grand Rapids..... Almont..... Reading..... Wessex..... Vicksburg..... Tuskegee..... South Haven..... Coopersville..... Average.....	{ G.† { F.†	..... ..... ..... ..... ..... ..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... ..... ..... ..... ..... ..... .....	17.20 16.60 17.40 18.65 19.28 18.20 18.30 18.00 18.65 18.70 18.55	0.60 0.64 0.58 0.78 0.78 0.14 0.96 0.60 0.16 0.68 0.59	16.00 16.76 18.07 18.50 17.42 18.16 17.04 18.05 18.54 17.87 17.70
A 177* A 2901 A 3135 A 3153	Tripton Fertilizer..... Tripton Fertilizer..... Tripton Fertilizer..... Tripton Fertilizer.....	Quincy..... Jackson..... Shepherd..... Covert..... Average.....	{ G.† { F.†	..... ..... ..... ..... .....	..... ..... ..... ..... .....	14.60 15.20 15.65 15.10 15.14	1.04 1.18 1.04 0.80 1.02	12.00 13.56 14.02 14.61 14.30
A 2958 A 3081 A 3185 A 3272 A 3521*	Usenore Fertilizer..... Usenore Fertilizer..... Usenore Fertilizer..... Usenore Fertilizer..... Usenore Fertilizer.....	Maybee..... Zeeland..... Clarksville..... Richmond..... Charlotte..... Average.....	{ G.† { F.†	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....	13.65 12.90 13.05 14.70 12.75 13.61	1.14 0.44 0.56 0.84 0.54 0.70	12.00 12.51 12.46 13.49 13.86 12.21 12.91
A 2983 A 3008	Wolverine Phosphate..... Wolverine Phosphate.....	New Boston..... South Haven..... Average.....	{ G.† { F.†	..... ..... .....	..... ..... .....	11.80 11.65 11.73	0.63 0.44 0.54	10.00 11.21 11.19
A 3135 A 3150	Michigan Carbon Works Homestead Brands. Bean Fertilizer 1916..... Bean Fertilizer 1916.....	Shepherd..... Farmville..... Average.....	{ G.† { F.†	..... ..... .....	..... ..... .....	11.20 10.50 10.85	1.68 2.46 2.07	8.00 8.04 8.75

†Abbreviations for Guaranteed and Found.
*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.		Potash.	
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.		Available.
Michigan Carbon Works Homstead Brands.—Con.										
A 2761	Bialode Fertilizer.....	Clayton.....	0.56	0.16	0.28	0.82	13.35	1.62	10.00	1.00
A 2772	Bialode Fertilizer.....	Riga.....	0.44	0.18	0.33	1.00	12.73	1.70	11.03	1.23
A 3245	Bialode Fertilizer.....	Petersburg.....	0.58	0.20	0.26	0.95	13.20	1.72	11.48	1.31
A 3451*	Bialode Fertilizer.....	Coopersville.....	0.46	0.15	0.27	1.04	12.60	1.16	11.44	1.06
A 3522*	Bialode Fertilizer.....	Charlotte.....	0.48	0.14	0.21	0.83	11.50	0.81	10.69	1.18
	Average.....		0.50	0.17	0.27	0.94	12.68	1.40	11.28	0.85
A 1998	Bone Black Fertilizer 1918.....	Grand Rapids.....	0.83	0.49	0.35	1.67	10.40	1.58	8.00	1.13
A 2915	Bone Black Fertilizer 1918.....	Jackson.....	1.01	0.51	0.26	1.78	10.70	1.26	8.82	1.28
A 2905	Bone Black Fertilizer 1918.....	South Haven.....	0.89	0.47	0.32	1.68	10.35	1.78	8.57	1.33
A 3007	Bone Black Fertilizer 1918.....	Homer.....	0.99	0.47	0.32	1.78	10.50	1.38	9.12	1.20
A 3612*	Bone Black Fertilizer 1918.....		1.12	0.39	0.27	1.78	11.45	2.00	9.45	1.13
	Average.....		0.97	0.47	0.30	1.74	10.68	1.60	9.08	1.20
A 2712	Bone Black Fertilizer with Potash.....	Reading.....	0.87	0.46	0.38	1.65	10.73	2.04	8.00	1.28
A 3528*	Bone Black Fertilizer with Potash.....	Dimondale.....	0.61	0.50	0.44	1.55	10.35	1.32	9.03	1.20
A 3611*	Bone Black Fertilizer with Potash.....	Homer.....	0.93	0.43	0.40	1.76	10.50	1.36	9.14	1.20
	Average.....		0.80	0.46	0.41	1.67	10.52	1.57	8.95	1.20
A 3325	Bone Black Sugar Beet Fertilizer.....	Fairgrove.....	0.40	0.24	0.29	0.82	10.10	0.90	9.00	1.26
A 3333	Bone Black Sugar Beet Fertilizer.....	Bay City.....	0.53	0.19	0.30	1.02	12.40	1.42	10.98	1.15
A 3339	Bone Black Sugar Beet Fertilizer.....	Bay City.....	0.42	0.24	0.34	1.00	11.60	1.30	10.30	1.18
	Average.....		0.45	0.22	0.31	0.98	11.37	1.21	10.15	1.20
A 2575	Special Potash Fertilizer.....	Romulus.....	0.40	0.24	0.34	0.82	11.10	1.38	8.00	2.00
A 3186	Special Potash Fertilizer.....	Clarksville.....	0.29	0.22	0.40	0.91	11.10	1.28	9.72	2.14
A 3484	Special Potash Fertilizer.....	Graafshap.....	0.49	0.15	0.31	0.95	10.25	1.20	9.82	2.11
	Average.....		0.39	0.20	0.35	0.94	10.82	1.29	9.53	2.13

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.	Available.	
Michigan State Grange Brands.—Continued.										
A 3251	Wheat Fertilizer No. 2	Daivson.....	{ G.† { F.†				12.15	0.72	10.00 11.43	
A 2620	Acid Phosphate 10% Niagara Brands.	Romeo.....	{ G.† { F.†				10.98	0.56	10.00 10.42	
A 3244	Pean Grower.....	Detroit.....	{ G.† { F.†	0.87	0.46	0.37	1.65 1.70	2.32	8.00 8.43	1.00 1.26
A 2780 A 2926	Dissolved Bone Phosphate. Dissolved Bone Phosphate.	Adrian..... Milan.....	{ G.† { F.†				16.20 16.35	0.82 0.58	14.00 15.38 15.77	
A 3357	General Crop Fertilizer.....	Average..... Inlay City.....	{ G.† { F.†	0.66	0.16	0.30		0.70	15.58 10.00 11.19	
A 3271 A 3286	Grain and Grass Grower..... Grain and Grass Grower.....	Richmond..... Lannett.....	{ G.† { F.†	0.35 0.44	0.26 0.23	0.34 0.35	0.82 1.02	9.15 9.05	7.00 7.83 7.99	1.00 1.00 1.02
A 2770 A 2833 A 2832 A 2962	High Grade Phosphate..... High Grade Phosphate..... High Grade Phosphate..... High Grade Phosphate.....	Average..... Adrian..... Plymouth..... Wills..... Maybee.....	{ G.† { F.†	0.40	0.25	0.34	0.99	9.10	7.91	1.01
A 2924 A 3057	Wheat and Corn Producer 1916. Wheat and Corn Producer 1916.	Average..... Milan..... Monroe.....	{ G.† { F.†				13.33	0.73	16.00 16.79 18.13 18.90 17.48	
A 3057	Average.....	Average.....					13.33	0.73	17.60	
A 2924 A 3057	Wheat and Corn Producer 1916. Wheat and Corn Producer 1916.	Milan..... Monroe.....	{ G.† { F.†	0.61 0.54	0.21 0.13	0.25 0.27	0.89 1.07 0.91	1.54 10.23	9.00 9.91 8.82	1.00 1.16 1.12
A 3057	Average.....	Average.....		0.56	0.17	0.26	0.99	10.84	9.36	1.14

Northwestern Horseshoe Brands.										
A 167*	Acidulated Bone Phosphate and Potash.....	{ G.† F.† }	0.53	0.15	0.22	0.82	12.00	1.16	10.00	1.00
A 2709	Acidulated Bone Phosphate and Potash.....	{ G.† F.† }	0.46	0.16	0.35	0.97	12.85	1.72	10.84	1.41
A 2802	Acidulated Bone Phosphate and Potash.....	{ G.† F.† }	0.60	0.18	0.27	1.05	13.35	1.46	11.89	1.24
A 2811	Acidulated Bone Phosphate and Potash.....	{ G.† F.† }	0.69	0.21	0.30	1.20	13.58	1.86	11.72	1.03
A 2912	Acidulated Bone Phosphate and Potash.....	{ G.† F.† }	0.68	0.19	0.28	1.15	13.20	1.40	11.80	1.16
	Average.....		0.59	0.18	0.25	1.05	13.00	1.52	** 48	1.21
A 196*	Animal Bone Phosphate Manure.....	{ G.† F.† }	0.53	0.10	0.21	0.82	8.10	0.60	7.00	1.20
A 2378	Animal Bone Phosphate Manure.....	{ G.† F.† }	0.41	0.26	0.26	0.93	9.70	1.08	8.62	1.03
A 3365	Animal Bone Phosphate Manure.....	{ G.† F.† }	0.44	0.32	0.18	0.91	8.95	1.76	7.19	1.02
	Average.....		0.46	0.23	0.21	0.90	8.92	1.15	7.77	1.08
A 3125	Bean Special 1916.....	{ G.† F.† }	0.97	0.48	0.42	1.65	11.05	2.20	8.00	1.00
	Average.....		0.85	0.48	0.41	1.74	10.66	1.76	8.85	1.33
A 117*	Corn and Wheat Grower 1916.....	{ G.† F.† }	0.85	0.47	0.41	1.65	10.25	1.86	8.00	1.00
A 2761	Corn and Wheat Grower 1916.....	{ G.† F.† }	0.79	0.49	0.39	1.67	10.75	2.08	8.39	1.18
A 3160	Corn and Wheat Grower 1916.....	{ G.† F.† }	0.95	0.44	0.42	1.81	10.75	1.64	8.67	1.09
A 3355	Corn and Wheat Grower 1916.....	{ G.† F.† }	1.04	0.43	0.27	1.74	10.60	1.32	9.11	1.34
A 3606*	Corn and Wheat Grower 1916.....	{ G.† F.† }	0.61	0.54	0.58	1.73	10.95	1.88	9.28	1.17
	Average.....		0.85	0.48	0.41	1.74	10.66	1.76	9.07	1.34
A 118*	Corn and Wheat Grower 1918.....	{ G.† F.† }	1.14	0.37	0.30	1.65	11.05	2.22	8.00	1.00
A 3386	Corn and Wheat Grower 1918.....	{ G.† F.† }	1.11	0.35	0.30	1.76	10.80	1.08	8.83	1.33
	Average.....		1.13	0.36	0.30	1.79	10.93	1.65	9.25	1.00
A 169*	Dissolved Ammoniated Bone Phosphate.....	{ G.† F.† }	1.08	0.44	0.28	1.65	15.05	1.16	12.00	1.00
A 2816	Dissolved Ammoniated Bone Phosphate.....	{ G.† F.† }	1.19	0.40	0.29	1.80	15.70	1.06	13.89	1.34
A 3329	Dissolved Ammoniated Bone Phosphate.....	{ G.† F.† }	1.16	0.49	0.23	1.88	15.20	0.94	14.04	1.00
	Average.....		1.14	0.44	0.27	1.85	15.32	1.05	14.27	1.00
A 120*	F. and F. Fertilizer.....	{ G.† F.† }	0.45	0.17	0.21	0.82	11.80	0.72	10.00	1.00
A 2689	F. and F. Fertilizer.....	{ G.† F.† }	0.49	0.19	0.19	0.87	12.30	1.08	11.08	1.00
A 2707	F. and F. Fertilizer.....	{ G.† F.† }	0.65	0.21	0.25	1.11	12.60	1.52	11.22	1.00
A 2728	F. and F. Fertilizer.....	{ G.† F.† }	0.42	0.20	0.28	0.90	13.65	1.58	12.07	1.00
A 2803	F. and F. Fertilizer.....	{ G.† F.† }	0.43	0.22	0.30	0.95	13.95	1.84	12.11	1.00
A 2814	F. and F. Fertilizer.....	{ G.† F.† }	0.57	0.19	0.25	1.01	13.65	2.06	11.59	1.00
A 2888	F. and F. Fertilizer.....	{ G.† F.† }	0.31	0.23	0.26	0.80	12.95	1.76	11.19	1.00
	Average.....		0.47	0.20	0.25	0.92	12.99	1.51	11.48	1.00

†Abbreviations for Guaranteed and Found.

*Tail Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.		Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.		Available.
Northwestern Horseshoe Brand.—Con.									
A 166*	Garden City Superphosphate with Potash.	Union City.	0.84	0.48	0.39	1.65	10.65	1.56	8.00
A 3164	Garden City Superphosphate with Potash.	Coloma.	0.80	0.47	0.40	1.71	10.80	1.78	9.09
		Average.	0.82	0.48	0.39	1.69	10.73	1.67	9.06
A 2688	16% Phosphate.	Coldwater.							16.00
A 2706	16% Phosphate.	Reading.					18.28	1.22	17.06
A 2805	16% Phosphate.	Stephenson.					18.15	0.72	17.43
A 2812	16% Phosphate.	Potoskey.					19.70	0.76	18.94
A 3470*	16% Phosphate.	Fillmore.					19.30	0.88	18.42
A 3605*	16% Phosphate.	North Adams.					18.70	1.12	17.58
		Average.					18.95	0.82	18.13
A 195*	2 Potash Fertilizer.	Reading.	0.62	0.10	0.19	0.82	18.84	0.92	17.92
A 2687	2 Potash Fertilizer.	Coldwater.	0.52	0.13	0.16	0.91	10.75	1.14	8.00
A 2765	2 Potash Fertilizer.	Adrian.	0.36	0.21	0.38	0.81	9.30	0.62	8.68
A 2813	2 Potash Fertilizer.	Potoskey.	0.34	0.22	0.38	0.98	10.40	1.78	8.62
		Average.	0.46	0.17	0.28	0.94	10.63	1.16	9.49
A 168*	Potash Manure 1916.	Union City.	0.55	0.18	0.25	0.91	10.28	1.18	9.10
A 2708	Potash Manure 1916.	Reading.	0.42	0.20	0.31	0.82	12.23	1.14	8.00
A 2729	Potash Manure 1916.	Hillsdale.	0.49	0.20	0.32	0.97	10.58	1.02	9.56
A 2971	Potash Manure 1916.	Saline.	0.20	0.27	0.40	1.01	11.10	1.12	9.98
		Average.	0.42	0.21	0.32	0.87	11.80	1.02	10.78
A 2763	Quick Acting Phosphate.	Adrian.			0.32	0.95	11.43	1.08	10.35
A 2886	Quick Acting Phosphate.	New Boston.					11.30	0.52	10.78
A 3379	Quick Acting Phosphate.	Wilmet.					11.15	0.54	10.61
		Average.					11.65	0.85	10.20
							11.20	0.64	10.56

A 2887	Square Deal Phosphate.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	14.00	.....
A 3270	Square Deal Phosphate.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	15.75	.....
A 3277	Square Deal Phosphate.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	15.75	.....
	Average.....		.....	.....	.....	.....	.....	.....	.....	15.20	.....
			.....	.....	.....	.....	.....	.....	.....	15.16	.....
A 3217	Sugar Beet Fertilizer 1916.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	9.00	1.00
A 3350	Sugar Beet Fertilizer 1916.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	8.83	1.00
			.....	.....	.....	.....	.....	.....	.....	9.43	1.13
	Average.....		.....	.....	.....	.....	.....	.....	.....	9.13	1.07
A 2804	XXX Fertilizer.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	12.00	1.00
A 3244	XXX Fertilizer.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	14.09	1.22
			.....	.....	.....	.....	.....	.....	.....	13.13	1.04
	Average.....		.....	.....	.....	.....	.....	.....	.....	13.61	1.13
Packers Boars Head Brands.											
A 199*	Ammoniated Bone Phosphate and Potash.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	10.00	1.00
A 3350	Ammoniated Bone Phosphate and Potash.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	10.67	1.58
A 3391	Ammoniated Bone Phosphate and Potash.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	11.36	1.16
			.....	.....	.....	.....	.....	.....	.....	11.83	1.26
	Average.....		.....	.....	.....	.....	.....	.....	.....	11.29	1.33
A 3414	Corn and Wheat Grower 1916.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	8.00	1.00
A 3486*	Corn and Wheat Grower 1916.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	8.13	0.08
			.....	.....	.....	.....	.....	.....	.....	9.00	1.44
	Average.....		.....	.....	.....	.....	.....	.....	.....	8.57	0.76
A 3415	Corn and Wheat Grower 1918.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	8.00	.....
A 3485*	Corn and Wheat Grower 1918.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	8.40	.....
			.....	.....	.....	.....	.....	.....	.....	9.11	.....
	Average.....		.....	.....	.....	.....	.....	.....	.....	8.76	.....
A 2703	Faultless Grain Grower.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	7.00	1.00
A 2735	Faultless Grain Grower.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	7.93	1.31
A 3109	Faultless Grain Grower.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	8.13	1.02
A 3491*	Faultless Grain Grower.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	8.65	1.11
A 3610*	Faultless Grain Grower.....	{ F.†	.....	.....	.....	.....	.....	.....	.....	8.23	1.07
			.....	.....	.....	.....	.....	.....	.....	8.38	0.97
	Average.....		.....	.....	.....	.....	.....	.....	.....	8.14	1.10
A 3111	Gilt Edge Phosphate.....	{ G.†	.....	.....	.....	.....	.....	.....	.....	14.00	.....
		{ F.†	.....	.....	.....	.....	.....	.....	.....	13.50	.....

†Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.		Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Insoluble.		Available.
Packers Boars Head Brands.—Con.								
A 2704	New Compound	Litchfield.....	{ G.† F.†			0.82		10.00
A 2849	New Compound	Stark.....		0.64	0.21	1.15	1.94	10.94
A 2807	New Compound	Walz.....		0.53	0.19	0.26	1.64	11.56
A 2930	New Compound	Willis.....		0.49	0.20	0.22	1.94	11.36
A 3110	New Compound	Harlem.....		0.75	0.18	0.14	2.28	10.77
				0.55	0.14	0.25	1.76	10.64
		Average.....		0.59	0.18	0.24	1.91	11.05
A 2909*	New Compound and Potash Fertilizer.....	Pittsford.....	{ G.† F.†			0.82		8.00
A 2736	New Compound and Potash Fertilizer.....	Osseo.....		0.58	0.13	0.24	1.28	9.12
A 3357*	New Compound and Potash Fertilizer.....	Fowler.....		0.38	0.25	0.37	1.88	9.32
				0.50	0.18	0.33	1.40	8.65
		Average.....		0.49	0.19	0.31	1.52	9.03
A 2705	16% Phosphate.....	Litchfield.....	{ G.† F.†					16.00
A 3143	16% Phosphate.....	Moline.....					0.88	16.92
A 3298	16% Phosphate.....	Brown City.....					0.62	17.43
							0.74	17.61
		Average.....				†		
							0.75	17.32
A 3427	Phosphotash Fertilizer.....	Doster.....	{ G.† F.†					12.00
							0.72	12.63
A 3416	Soluble Phosphate.....	Holland.....	{ G.† F.†				0.70	10.20
A 3300	Success Fertilizer.....	Pontiac.....	{ G.† F.†			1.75		12.00
A 3393	Success Fertilizer.....	Vernon.....		1.10	0.48	0.26	0.86	14.89
A 3492*	Success Fertilizer.....	Harlem.....		1.23	0.44	0.25	1.46	13.41
				1.14	0.33	0.29	1.70	13.45
		Average.....		1.16	0.42	0.26	1.84	13.92

A 3285	Sugar Beet Grower 1916	{ G.† F.†	0.45	0.17	0.29	0.82	10.00	0.84	9.60	1.60
A 3287	Sugar Beet Grower 1916	{ G.† F.†	0.30	0.19	0.39	0.91	10.75	1.22	9.35	1.01
A 3401	Sugar Beet Grower 1916	{ G.† F.†	0.31	0.23	0.36	0.88	11.30	1.02	10.28	1.16
A 3403	Sugar Beet Grower 1916	{ G.† F.†	0.36	0.18	0.31	1.05	13.05	1.44	11.61	1.01
	Average		0.43	0.19	0.31	0.96	11.28	1.13	10.15	1.09
A 2550	Sure Growth Potash Manure 1916	{ G.† F.†	0.40	0.23	0.37	0.82	10.60	1.32	8.60	1.60
A 3315	Sure Growth Potash Manure 1916	{ G.† F.†	0.49	0.18	0.28	1.00	10.85	1.28	9.08	1.24
A 3402	Sure Growth Potash Manure 1916	{ G.† F.†	0.42	0.21	0.34	0.97	11.03	1.01	10.01	1.18
A 3356*	Sure Growth Potash Manure 1916	{ G.† F.†	0.43	0.13	0.45	1.01	11.35	1.06	10.49	1.08
A 3601*	Sure Growth Potash Manure 1916	{ G.† F.†	0.55	0.18	0.21	0.94	11.10	1.46	9.64	1.27
	Average		0.46	0.15	0.33	0.97	11.03	1.27	9.76	1.21
A 3340	World of Good Superphosphate with Potash.	{ G.† F.†	1.02	0.65	0.23	1.65	11.15	2.00	8.60	1.60
	Armour Fertilizer Works, Chicago, Ill.									
A 142*	Acid Phosphate.	{ G.† F.†							16.60	
A 2735	Acid Phosphate.	{ G.† F.†					18.00	0.14	17.86	
A 3037	Acid Phosphate.	{ G.† F.†					17.05	0.44	16.61	
A 3064	Acid Phosphate.	{ G.† F.†					17.13	1.99	15.14	
A 3478*	Acid Phosphate.	{ G.† F.†					17.70	2.58	15.12	
	Average						18.50	1.34	17.16	
A 142*	Ammoniated Phosphate No. 2	{ G.† F.†	0.80	0.66	0.20	1.65	17.68	1.30	16.38	
A 2753	Ammoniated Phosphate No. 2	{ G.† F.†	0.53	0.51	0.40	1.66	11.60	1.38	10.22	
A 3041	Ammoniated Phosphate No. 2	{ G.† F.†	0.81	0.49	0.24	1.44	11.75	2.07	9.68	
A 3056	Ammoniated Phosphate No. 2	{ G.† F.†	0.88	0.47	0.18	1.53	12.90	1.46	11.44	
A 3635*	Ammoniated Phosphate No. 2	{ G.† F.†	0.70	0.51	0.21	1.42	11.85	1.28	10.57	
	Average		0.74	0.53	0.25	1.52	12.20	1.38	10.82	
A 2727	Bone Meal	{ G.† F.†	0.72	1.14	0.67	1.65	12.06	1.51	10.55	
A 2751	Bone Meal	{ G.† F.†	0.68	1.24	0.37	1.65	27.00			
A 3025	Bone Meal	{ G.† F.†	0.76	1.01	0.27	2.53	25.45			
A 3038	Bone Meal	{ G.† F.†	0.49	1.10	0.80	2.29	26.75			
A 3040	Bone Meal	{ G.† F.†	0.36	0.63	0.47	2.01	27.20			
	Average		0.60	1.02	0.52	1.46	27.70			
						2.14	32.60			
							27.94			

†Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid		Potash.	
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.		Insoluble.	Available.
Armour Fertilizer Works, Chicago, Ill.—Con.									
A 2657	Cereal Phosphate.....	Grand Prairie.....						10.00	
A 2877	Cereal Phosphate.....	Belleville.....				11.25	0.28	10.97	
A 3161	Cereal Phosphate.....	Wauvliet.....				10.65	0.74	9.91	
	Average.....					10.88	0.50	10.38	
A 122*	Grain & Bean Special.....	Capac.....	0.46	0.41	0.82	9.95	1.16	8.00	2.00
A 2754	Grain & Bean Special.....	Hudson.....	0.26	0.25	1.05	9.25	1.48	7.77	1.63
A 3027	Grain & Bean Special.....	Plainwell.....	0.31	0.37	0.90	9.40	1.08	8.32	1.81
A 3137	Grain & Bean Special.....	Grand Rapids.....	0.58	0.35	1.14	9.70	1.18	8.52	1.98
A 3576*	Grain & Bean Special.....	Carson City.....	0.32	0.37	0.81	9.25	0.90	8.35	2.05
	Average.....		0.39	0.35	0.91	9.51	1.16	8.35	1.90
A 2867	Grain Grower.....	Wayne.....	1.16	0.48	1.65	8.38	1.82	8.00	2.00
A 3135	Grain Grower.....	Grand Rapids.....	0.72	0.51	1.90	11.20	2.70	6.56	2.21
A 3465*	Grain Grower.....	Zeeland.....	0.43	0.65	1.63	12.25	3.10	8.50	1.80
A 3804*	Grain Grower.....	Richland.....	1.04	0.54	1.74	11.00	2.60	9.15	2.08
	Average.....		0.84	0.55	1.88	10.71	2.56	8.40	2.00
A 3629*	High Grade Ammoniated Phosphate.....	Hudson.....	0.79	0.74	1.65	15.05	2.72	12.00	
A 129*	Michigan Special.....	Eaton Rapids.....	0.47	0.51	0.82	9.95	1.58	8.00	1.00
A 2673	Michigan Special.....	Lansing.....	0.32	0.37	1.05	9.53	1.24	8.37	1.06
A 2752	Michigan Special.....	Hudson.....	0.40	0.28	0.93	10.40	1.60	8.80	1.20
A 2784	Michigan Special.....	Blissfield.....	0.51	0.38	1.13	9.95	1.68	8.27	1.01
A 3028	Michigan Special.....	Plainwell.....	0.85	0.25	0.95	10.90	1.18	9.72	1.16
A 3055	Michigan Special.....	Dowagiac.....	0.46	0.35	1.02	9.60	1.22	8.38	1.08
A 3464*	Michigan Special.....	Zeeland.....	0.49	0.44	1.11	9.98	2.18	7.80	1.17
	Average.....		0.43	0.38	1.01	10.04	1.52	8.52	1.13

A 2556	Phosphate and Potash Special.	Grand Blanc.	{ G. ⁺ F. ⁺			11.13	0.36	10.00	1.00
A 3212	Phosphate and Potash Special.	Detroit.				11.05	0.44	10.77	0.97
A 3293	Phosphate and Potash Special.	Yale.				11.25	0.72	10.61	0.84
A 3520*	Phosphate and Potash Special.	Charlotte.				11.85	1.14	10.71	1.26
	Average.					11.32	0.66	10.66	0.88
A 1999	Sheep Manure.	Portage.	{ G. ⁺ F. ⁺	0.46	0.97	1.24		1.00	1.00
A 3001	Sheep Manure.	Portage.		0.43	0.96	1.61	0.18	1.42	1.58
A 3002	Sheep Manure.	Portage.		0.31	0.92	2.09	0.66	2.44	1.60
	Average.			0.55	0.92	1.78	0.26	2.49	1.42
A 3596*	Special Grain Grower.	Downing.	{ G. ⁺ F. ⁺	0.31	0.95	1.83	0.37	2.12	1.53
A 3702*	Special Grain Grower.	Mason.		0.69	0.50	1.65		8.00	1.00
	Average.			0.65	0.47	1.39	1.62	8.78	1.13
A 2756	Standard.	Hudson.	{ G. ⁺ F. ⁺	0.67	0.49	1.43	1.99	8.71	1.23
A 3020	Standard.	Portage.		0.38	0.29	0.82		8.00	8.00
A 3031	Standard.	Dexter.		0.56	0.28	0.87	1.30	7.85	2.98
A 3072	Standard.	Decatur.		0.41	0.38	0.95	0.82	8.63	3.18
A 3139	Standard.	Grand Rapids.		0.46	0.39	1.07	1.20	9.25	2.32
A 3173	Standard.	Baroda.		0.32	0.25	1.11	0.96	8.79	3.14
	Average.			0.34	0.33	0.77	1.68	8.72	3.69
				0.41	0.32	0.83	0.62	8.13	2.77
A 3036	Star Phosphate.	Alleghen.	{ G. ⁺ F. ⁺		0.20	0.93	1.10	8.56	3.01
A 3008	Star Phosphate.	Coopersville.						14.00	
A 3296	Star Phosphate.	Ann Arbor.				16.65	1.21	15.41	
A 3477*	Star Phosphate.	Coopersville.				16.55	1.32	15.48	
	Average.					17.00	0.98	16.62	
A 121*	Wheat, Corn and Oats Special.	Capac.	{ G. ⁺ F. ⁺	0.46	0.43	0.82	1.32	15.43	1.00
A 2672	Wheat, Corn and Oats Special.	Lansing.		0.41	0.26	0.97	0.95	8.01	0.74
A 2866	Wheat, Corn and Oats Special.	Wayne.		0.51	0.22	1.01	0.83	7.77	1.02
A 3026	Wheat, Corn and Oats Special.	Plainwell.		0.56	0.32	1.12	1.00	8.72	0.90
A 3339	Wheat, Corn and Oats Special.	Hudsonville.		0.33	0.26	0.70	0.50	8.28	0.83
A 3479*	Wheat, Corn and Oats Special.	Coopersville.		0.30	0.30	0.90	0.55	8.17	1.26
	Average.			0.43	0.33	0.97	0.30	7.07	0.89
						0.97	0.39	8.00	0.96

* Abbreviations for Guaranteed and Found.

* Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.		Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.		Available.
Armour Fertilizer Works.—Con.									
A 2864	1-10 Fertilizer.	Wayne.	(G.† {F.†	0.45	0.30	0.16	0.82	12.55	10.00
A 3007	1-10 Fertilizer.	Coopersville.		0.59	0.41	0.17	0.91	12.80	11.09
A 3205	1-10 Fertilizer.	Ann Arbor.		0.53	0.37	0.15	1.03	12.60	11.62
A 3226	1-10 Fertilizer.	Ida.		0.49	0.34	0.15	0.98	12.50	11.04
	Average.			0.52	0.35	0.16	1.03	12.61	11.21
A 3631*	12-2 Fertilizer.	Hudson.	(G.† {F.†					13.10	12.20
A 3630*	12-4 Fertilizer.	Hudson.	(G.† {F.†					14.75	12.65
A 2865	1-9-1 Fertilizer.	Wayne.	(G.† {F.†	0.67	0.39	0.23	0.82	11.25	9.00
A 3595*	1-9-1 Fertilizer.	Hinchman.		0.33	0.30	0.21	0.84	10.40	9.71
	Average.			0.50	0.35	0.22	1.07	10.83	9.54
A 144*	1-12-1 Fertilizer.	Albion.	(G.† {F.†	0.29	0.33	0.26	0.82	14.60	12.00
A 2726	1-12-1 Fertilizer.	Montgomery.		0.41	0.34	0.26	1.01	15.95	12.76
A 3029	1-12-1 Fertilizer.	Plainwell.		0.36	0.36	0.26	0.98	13.75	13.91
A 3162	1-12-1 Fertilizer.	Coloma.		0.46	0.29	0.23	0.98	15.25	12.69
A 3463*	1-12-1 Fertilizer.	Zeeland.		0.35	0.26	0.18	0.79	13.80	13.25
	Average.			0.37	0.32	0.24	0.93	14.66	11.45
A 3597*	2-10-4 Fertilizer.	Coloma.	(G.† {F.†	0.87	0.62	0.40	1.65	13.68	12.81
A 2634*	2-10-4 Fertilizer.	Hudson.		0.80	0.56	0.42	1.81	13.75	10.00
A 3802*	2-10-4 Fertilizer.	Richland.		0.76	0.50	0.40	1.66	13.15	11.09
	Average.			0.81	0.57	0.41	1.79	13.68	10.15
A 3590*	2-12-2 Fertilizer.	Decatur.	(G.† {F.†	0.92	0.64	0.38	1.65	15.10	10.40
A 2633*	2-12-2 Fertilizer.	Hudson.		0.78	0.49	0.35	1.62	13.63	12.00
A 3675*	2-12-2 Fertilizer.	Ann Arbor.		0.70	0.52	0.41	1.63	15.50	10.34
A 3803*	2-12-2 Fertilizer.	Richland.		0.85	0.54	0.37	1.76	13.30	12.34
	Average.			0.81	0.55	0.38	1.74	14.38	12.10
								11.81	2.17

4-12-3 Fertilizer	G.†				3.20	12.00	8.00
Tuscarora Brands.							
A 3002 Acid Phosphate.....	{ G.† F.†				16.45	1.66	11.00 11.79
A 3087 Special Corn, Wheat & Bean Grower.....	{ G.† F.†	0.52 0.47	0.55 0.40	0.25 0.18	0.82 1.12 1.05	1.88 1.12	8.00 8.92 8.28
A 3701* Special Corn, Wheat & Bean Grower.....							1.00 1.27 1.55
Average.....		0.50	0.38	0.21	1.09	1.50	8.00
Special Standard.....	G.†				1.65		8.00
Standard.....	G.†				1.65		8.00
Tankage and Phosphate.....							2.00
A 3088 1-10 Fertilizer.....	{ G.† F.†	1.15	0.69	0.42	1.65 2.26	3.41	10.00 9.94
The Barrett Co., New York City, N. Y.							
A 3166 Arcadian Sulfate of Ammonia.....	{ G.† F.†				20.75 20.46		
A 3208 Arcadian Sulfate of Ammonia.....					20.82		
Average.....					20.64		
A 3411 Blood and Bone Fertilizer.....	{ G.† F.†	3.02	1.39	0.63	5.95 5.04	13.47 19.85	
R. Binder & Co., Battle Creek, Mich.							
A 3592 Ammoniated Phosphate.....	{ G.† F.†	1.37	0.40	0.13	1.65	4.10	12.00 14.75
A 3697* Ammoniated Phosphate.....		0.84	0.78	0.39	2.01	12.54	7.91
Average.....		1.11	0.59	0.26	1.96	8.32	11.33
E. Burton, St. Joseph, Mich.							
A 3170 Meat and Bone Phosphate.....	{ G.† F.†	0.86	3.35	1.61	5.82 5.82	6.29	5.89 5.39
Calumet Fertilizer Co., New Albany, Indiana.							
A 3034 Acid Phosphate.....	{ G.† F.†				15.55	0.60	11.00 14.95
A 3037 Acid Phosphate.....					16.65	0.84	15.81
A 3239 Acid Phosphate.....					18.85	3.70	15.15
A 3279 Acid Phosphate.....					15.70	0.92	14.78
Average.....					16.69	1.52	15.17

Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1910, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.	Available.	
A 138*	16% Acid Phosphate.	Eaton Rapids	{ G.†							
A 3589*	16% Acid Phosphate.	Lawton.	{ F.†							
		Average.								
A 3243	Black Soil Special.	Lulu.	{ G.†	0.10	0.09	0.22	0.42			5.00
A 3423	Black Soil Special.	Wayland.	{ F.†	0.13	0.10	0.25	0.41	2.12	5.07	4.51
		Average.						2.12	6.41	4.43
A 3501*	Bone Meal Tankage and Potash.	Zeeland.	{ G.†	0.11	0.10	0.25	0.46	0.90	5.74	4.47
			{ F.†	0.07	0.33	0.60	1.24			1.00
							1.00			1.16
A 137*	Bone Phosphate & Potash Mixture.	Eaton Rapids.	{ G.†	0.11	0.15	0.20	0.42			1.00
A 2908*	Bone Phosphate & Potash Mixture.	Flat Rock.	{ F.†	0.04	0.15	0.19	0.38	1.78	11.42	0.98
A 2977	Bone Phosphate & Potash Mixture.	Britton.		0.06	0.10	0.28	0.44	1.56	10.79	0.97
A 3058	Bone Phosphate & Potash Mixture.	Niles.		0.20	0.08	0.21	0.49	1.36	11.29	1.12
A 3465*	Bone Phosphate & Potash Mixture.	Zeeland.		0.13	0.12	0.27	0.52	2.80	10.80	1.46
		Average.						1.54	13.11	0.70
			0.11	0.12	0.23	0.46	13.29	1.81	11.48	1.05
A 2975	Coburn's Special with Potash.	Britton.	{ G.†	0.08	0.15	0.40	0.60			8.50
A 3248	Coburn's Special with Potash.	Petersburg.	{ F.†	0.09	0.14	0.39	0.62	0.78	9.67	0.79
A 3280	Coburn's Special with Potash.	Memphis.		0.07	0.16	0.35	0.58	1.42	8.58	0.69
A 3240	Coburn's Special with Potash.	Lulu.		0.07	0.17	0.41	0.65	1.58	8.57	0.53
		Average.						1.30	9.85	0.44
			0.08	0.16	0.38	0.62	10.44	1.27	9.17	0.61
	Extra Ammoniated Bone Phosphate.									
			{ G.†							
A 116*	Grain Grower.	Imlay City.	{ F.†	1.15	0.23	0.23	1.64			2.00
A 153*	Grain Grower.	Mason.		1.11	0.22	0.22	1.55	1.54	8.36	1.96
A 3574*	Grain Grower.	Carson City.		1.24	0.20	0.25	1.66	1.31	9.24	2.29
		Average.						1.40	8.99	2.04
			1.17	0.22	0.22	1.61	10.37	1.40	8.87	2.13

A 2976	Half Six Three	{ G.† { F.†	0.10	0.12	0.34	0.42	7.55	1.12	6.00	8.00
A 3241	Half Six Three	{ G.† { F.†	0.05	0.12	0.27	0.56	6.90	1.12	6.43	2.94
A 3282	Half Six Three	{ G.† { F.†	0.14	0.12	0.15	0.46	8.00	0.90	6.48	2.57
A 3332	Half Six Three	{ G.† { F.†	0.11	0.12	0.23	0.46	7.30	1.12	6.18	2.56
A 3334	Half Six Three	{ G.† { F.†	0.08	0.14	0.38	0.60	8.45	1.18	7.27	3.05
	Average		0.10	0.13	0.27	0.50	7.64	1.17	6.47	2.77
A 132*	Half-Ten-Two	{ G.† { F.†	0.09	0.09	0.23	0.41	12.35	1.58	10.00	2.00
						0.41			10.77	1.71
A 136*	Half Thirteen One	{ G.† { F.†	0.08	0.10	0.24	0.41	15.35	2.16	13.00	1.00
A 3571*	Half Thirteen One	{ G.† { F.†	0.05	0.10	0.31	0.46	15.35	2.20	13.19	0.88
	Average		0.07	0.10	0.27	0.44	15.35	2.18	13.17	0.94
A 115*	High Grade Manure	{ G.† { F.†	0.85	0.20	0.26	1.23	11.35	2.16	9.00	1.00
A 3178	High Grade Manure	{ G.† { F.†	0.62	0.25	0.52	1.39	11.35	1.64	9.19	1.23
A 3281	High Grade Manure	{ G.† { F.†	0.36	0.21	0.38	0.95	10.80	1.82	8.98	1.00
A 3311	High Grade Manure	{ G.† { F.†	0.53	0.19	0.50	1.22	11.85	1.40	10.45	0.95
	Average		0.59	0.21	0.42	1.22	11.34	1.76	9.58	1.08
A 3334	Onion and Beet Grower	{ G.† { F.†	1.26	0.19	0.39	1.64	7.65	0.68	6.00	2.00
A 3193	Onion and Beet Grower	{ G.† { F.†	1.22	0.18	0.34	1.84	8.10	1.42	6.97	2.04
A 3342	Onion and Beet Grower	{ G.† { F.†	1.03	0.25	0.58	1.74	8.10	1.22	6.68	2.13
A 3425	Onion and Beet Grower	{ G.† { F.†	0.96	0.19	0.36	1.51	8.55	1.06	6.88	2.17
	Average		1.12	0.20	0.37	1.69	8.10	1.09	7.49	1.74
A 3424	Phosphate and Potash	{ G.† { F.†							7.01	2.02
									10.00	2.00
							11.00	0.74	10.86	2.02
A 2891	Special Crop Grower	{ G.† { F.†	0.04	0.14	0.30	0.41	14.20	0.84	12.00	
A 3035	Special Crop Grower	{ G.† { F.†	0.15	0.12	0.26	0.48	14.80	0.94	13.36	
A 3059	Special Crop Grower	{ G.† { F.†	0.22	0.07	0.51	0.51	15.00	2.66	12.34	
A 3247	Special Crop Grower	{ G.† { F.†	0.18	0.13	0.28	0.59	13.70	0.92	12.78	
	Average		0.15	0.12	0.26	0.53	14.43	1.34	13.09	
A 3179	Special Dissolved Bone & Potash	{ G.† { F.†							13.00	1.00
A 3246	Special Dissolved Bone & Potash	{ G.† { F.†					15.40	0.80	14.60	1.11
A 3309	Special Dissolved Bone & Potash	{ G.† { F.†					15.35	1.50	13.85	1.05
							15.40	0.88	14.52	1.19
	Average						15.38	1.06	14.32	1.12

†Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.	Available.	
Calumet Fertilizer Co.—Con.										
A 3344	Special Pure Bone Meal.....	Mason. { G.† F.†	0.31	0.57	0.23	0.82	30.00			
A 3426	Special Pure Bone Meal.....	Wayland. { G.† F.†	0.38	0.59	0.27	1.11	31.30			
	Average.....		0.35	0.58	0.25	1.18	30.32			
A 157*	Ten Four.....	Mason. { G.† F.†					12.45	1.58	10.00	4.00
A 3683*	Ten Four.....	Cho. { G.† F.†					14.35	2.40	11.95	3.37
	Average.....						13.40	1.99	11.41	3.82
A 114*	Wheat, Corn and Oat Special.....	Inlay City. { G.† F.†	0.06	0.08	0.21	0.41	9.25	1.16	8.00	3.00
A 135*	Wheat, Corn and Oat Special.....	Eaton Rapids. { G.† F.†	0.07	0.10	0.28	0.35	9.80	1.24	8.56	3.13
A 156*	Wheat, Corn and Oat Special.....	Mason. { G.† F.†	0.12	0.09	0.23	0.44	9.90	1.26	8.64	2.72
A 194*	Wheat, Corn and Oat Special.....	Reading. { G.† F.†	0.05	0.08	0.26	0.39	10.35	1.38	8.77	3.15
A 3468*	Wheat, Corn and Oat Special.....	Zeeland. { G.† F.†	0.04	0.10	0.25	0.39	11.75	1.30	10.45	2.71
A 3502*	Wheat, Corn and Oat Special.....	Zeeland. { G.† F.†		0.09	0.28	0.37	10.90	1.42	9.48	2.98
A 3550*	Wheat, Corn and Oat Special.....	St. Johns. { G.† F.†	0.11	0.09	0.26	0.46	9.80	1.00	8.80	3.03
	Average.....		0.06	0.09	0.26	0.41	10.25	1.28	8.97	2.98
Chicago Feed & Fertilizer Co., Chicago, Ill.										
A 2676	Magie Pulverized Sheep Manure.....	Lansing. { G.† F.†	0.68	0.55	1.23	1.85	2.16	0.34	1.82	1.25
Cincinnati Plant Food Co., Cincinnati, Ohio.										
A 2507	Nurto Pulverized Sheep Manure.....	Detroit. { G.† F.†	0.28	0.46	1.24	2.00	1.00	0.18	1.32	1.50
	Average.....					1.98				2.03
Columbia Guano Co., Toledo, Ohio.										
A 3678*	14% Acid Phosphate.....	Ann Arbor. { G.† F.†					17.55	1.22	16.33	
	Bountiful Wheat Guano.....	Gt.				1.65				2.00
A 3274	Extra Dry Guano.....	Richmond. { G.† F.†	0.09	0.24	0.04	0.41	9.35	1.71	7.64	0.50
A 3677*	Goodwill Guano.....	Ann Arbor. { G.† F.†	0.40	0.15	0.16	0.82	9.20	1.98	7.22	1.11

A 3501*	Grain Ammoniated Phosphate.....	{ G.† F.† }	1.01	0.34	0.24	1.65	15.15	2.32	12.00	12.83
A 3679*	Growso Grain Guano.....	{ G.† F.† }	0.42	0.18	0.23	0.82	10.80	2.80	8.00	8.00
	Half and Half Bone and Phosphate.....	G.†				1.23	20.00			2.77
A 3183	High Grade 16% Acid Phosphate.....	{ G.† F.† }					18.80	2.52	16.00	
A 3275	High Grade 16% Acid Phosphate.....	{ G.† F.† }					18.30	2.38	16.98	
A 3363	High Grade 16% Acid Phosphate.....	{ G.† F.† }					18.20	2.60	16.20	
A 3599*	High Grade 16% Acid Phosphate.....	{ G.† F.† }					18.43	1.38	17.07	
	Average.....						18.44	2.07	16.37	
A 3273	Jack Tar Potash Mixture.....	{ G.† F.† }					11.30	2.01	10.00	2.00
A 3283	Jack Tar Potash Mixture.....	{ G.† F.† }					11.28	2.06	8.29	1.69
	Average.....						11.29	2.04	9.25	1.85
Darling & Company, Chicago, Ill.										
A 126*	16% Acid Phosphate.....	{ G.† F.† }					18.30	1.96	16.00	
A 2675	16% Acid Phosphate.....	{ G.† F.† }					17.28	1.06	16.34	
A 2750	16% Acid Phosphate.....	{ G.† F.† }					17.33	1.32	16.22	
A 3063	16% Acid Phosphate.....	{ G.† F.† }					17.20	1.00	16.20	
A 3104	16% Acid Phosphate.....	{ G.† F.† }					17.40	0.60	16.80	
A 3140	16% Acid Phosphate.....	{ G.† F.† }					18.05	1.34	16.71	
A 3461*	16% Acid Phosphate.....	{ G.† F.† }					19.38	1.64	17.74	
	Average.....						17.88	1.27	16.61	
A 3047	Big Harvest.....	{ G.† F.† }	0.76	0.52	0.38	1.65	16.20	3.52	10.00	3.60
A 3335	Big Harvest.....	{ G.† F.† }	0.55	0.67	0.35	1.66	14.40	4.14	10.56	2.83
A 3508*	Big Harvest.....	{ G.† F.† }	0.30	0.80	0.58	1.57	15.55	3.44	12.11	2.69
	Average.....		0.54	0.66	0.44	1.68	15.38	3.70	11.08	1.35
A 3436*	Chicago Brand.....	{ G.† F.† }	0.45	0.64	0.72	1.65	14.10	4.17	12.00	2.29
A 3616*	Chicago Brand.....	{ G.† F.† }	0.52	0.76	0.38	1.81	14.85	3.93	9.93	2.60
A 3692*	Chicago Brand.....	{ G.† F.† }	0.74	0.54	0.39	1.66	15.45	3.32	10.92	2.53
	Average.....		0.57	0.64	0.50	1.67	15.45	3.32	12.13	1.60
A 1904	Farmers Favorite.....	{ G.† F.† }	0.81	0.83	0.64	1.71	14.80	3.81	10.99	2.15
A 3334	Farmers Favorite.....	{ G.† F.† }	0.93	1.40	0.19	2.42	13.70	3.82	8.00	1.00
	Average.....		0.87	1.12	0.41	2.28	13.70	4.82	9.88	1.44
	Average.....		0.87	1.12	0.41	2.40	13.70	4.32	8.88	1.28
	Average.....		0.87	1.12	0.41	2.40	13.70	4.32	9.38	1.36

Abbreviations for Guaranteed and Found.

*Full Samples.

A 1995	Pure Ground Bone.....	(G.† { F.†	0.81	0.97	0.62	1.85 2.40	98.00 27.15	.....	.....	.....
A 125*	Sure Winner.....	(G.† { F.†	0.46	0.37	0.14	0.82	12.45	2.48	10.00	0.50
A 1993	Sure Winner.....	(G.† { F.†	0.17	0.42	0.39	0.98	13.15	2.52	9.97	0.59
A 2659	Sure Winner.....	(G.† { F.†	0.36	0.52	0.30	0.98	12.10	2.02	10.63	0.65
A 2674	Sure Winner.....	(G.† { F.†	0.28	0.55	0.31	0.94	12.80	2.34	10.08	0.54
A 2715	Sure Winner.....	(G.† { F.†	0.09	0.37	0.42	0.88	13.93	3.08	10.85	0.68
A 2999	Sure Winner.....	(G.† { F.†	0.29	0.26	0.29	0.84	12.25	2.34	9.91	0.80
A 3105	Sure Winner.....	(G.† { F.†	0.25	0.25	0.34	0.84	12.50	2.10	10.40	0.68
A 3307*	Sure Winner.....	(G.† { F.†	0.49	0.32	0.19	1.00	12.95	2.48	10.47	0.64
	Federal Chemical Co., Louisville, Ky.									
	Average.....		0.30	0.33	0.30	0.93	12.77	2.42	10.35	0.60
A 3432	A 1 Clay Land Fertilizer.....	(G.† { F.†	0.19	0.10	0.50	0.82	.....	.....	8.00	0.50
	Buchanan.....	(G.† { F.†	0.19	0.10	0.50	0.79	16.18	8.89	7.29	0.65
A 2789	A 1 Fertilizer.....	(G.† { F.†	0.22	0.19	0.40	0.82	17.65	4.12	12.00	.....
	Blissfield.....	(G.† { F.†	0.22	0.19	0.40	0.81	17.65	4.12	13.53	.....
A 2832	Bean Beet and Onion Grower.....	(G.† { F.†	0.13	0.08	0.31	0.41	17.85	10.07	8.00	1.00
A 3133	Bean Beet and Onion Grower.....	(G.† { F.†	0.28	0.07	0.20	0.55	17.80	6.18	7.78	1.05
A 3303	Bean Beet and Onion Grower.....	(G.† { F.†	0.11	0.06	0.22	0.39	19.15	8.64	11.02	1.40
	Average.....		0.17	0.07	0.24	0.48	18.27	8.30	9.97	1.07
A 133*	Black Land Special.....	(G.† { F.†	.....	.....	.....	.....	14.87	2.29	12.00	4.00
	Eaton Rapids.....	(G.† { F.†	.....	.....	.....	.....	14.87	2.29	12.58	3.86
A 3627*	Braden Formula.....	(G.† { F.†	0.44	0.13	0.28	0.82	15.15	4.14	11.01	8.00
	Hudson.....	(G.† { F.†	0.44	0.13	0.28	0.85	15.15	4.14	11.01	2.96
A 2666	Daybreak Champion Grain Grower.....	(G.† { F.†	0.08	0.15	0.16	0.41	20.23	8.50	9.00	0.50
A 2671	Daybreak Champion Grain Grower.....	(G.† { F.†	0.02	0.17	0.22	0.41	21.93	11.96	11.73	0.54
A 2933	Daybreak Champion Grain Grower.....	(G.† { F.†	0.07	0.26	0.13	0.46	19.10	9.78	9.97	0.46
A 2871	Daybreak Champion Grain Grower.....	(G.† { F.†	0.14	0.17	0.28	0.59	19.83	10.70	9.32	0.40
	Average.....		0.08	0.19	0.20	0.47	20.27	10.23	9.13	0.71
A 3318	Daybreak Champion Potash Fertilizer.....	(G.† { F.†	.....	.....	.....	.....	17.40	8.58	10.04	0.53
	Birch Run.....	(G.† { F.†	.....	.....	.....	.....	17.40	8.58	8.00	2.00
A 149*	Daybreak Favorite.....	(G.† { F.†	0.51	0.11	0.31	0.82	13.75	2.82	11.00	8.00
A 3555*	Daybreak Favorite.....	(G.† { F.†	0.29	0.07	0.24	0.60	17.20	3.28	10.93	3.27
	Average.....		0.40	0.09	0.28	0.77	15.48	3.05	13.92	1.88
										2.56

†Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Insoluble.	Available.	
A 3030 A 3034	Federal Chemical Co., Louisville, Ky.—Con. Double Phosphate and Potash Formula. Double Phosphate and Potash Formula.	(G.† { F.†							
		Doster.....				19.65	10.12	8.00	4.00
		Decatur.....				20.25	10.60	9.83	3.32
		Average.....				20.10	10.36	9.74	4.15
A 3467* A 3519* A 3607* A 3626*	Globe Grain and Grass Grower. Globe Grain and Grass Grower. Globe Grain and Grass Grower. Globe Grain and Grass Grower.	(G.† { F.†							
		Zachland.....	0.17	0.07	0.24	14.30	2.00	11.00	1.00
		Charlotte.....	0.68	0.10	0.34	16.35	4.60	11.75	0.66
		North Adams.....	0.16	0.23	0.56	14.08	3.36	10.72	1.08
A 3118 A 3345	Globe Tip Top Grain Grower. Globe Tip Top Potash Fertilizer.	(G.† { F.†							
		Hudson.....	0.19	0.69	0.23	16.95	4.84	12.11	0.82
		Average.....	0.14	0.12	0.26	15.42	3.70	11.72	0.87
		Sparta.....	0.20	0.69	0.26	19.00	9.92	9.08	0.50
A 3421 A 3615*	Half and Half Meal Mixture. Half and Half Meal Mixture.	(G.† { F.†							
		Eaton Rapids.....				17.45	7.28	10.17	0.47
		Wayland.....	0.72	0.50	0.19	20.55	11.67	9.18	
		Homer.....	1.37	0.14	0.63	21.05	11.14	9.91	
A 3455* A 3558*	High Grade Fertilizer. High Grade Fertilizer.	(G.† { F.†							
		Average.....	1.05	0.32	0.11	20.95	11.40	9.55	
		Grand Rapids.....	1.38	0.24	0.17	17.75	4.60	13.09	
		Kalamazoo.....	1.37	0.68	0.21	15.65	1.92	13.73	
A 3159 A 3196 A 3292 A 3459*	High Grade Phosphate. High Grade Phosphate. High Grade Phosphate. High Grade Phosphate.	(G.† { F.†							
		Average.....	1.38	0.16	0.19	16.70	3.29	13.41	
		Hartford.....				19.35	0.50	18.85	
		Charlotte.....				22.15	2.92	19.23	
A 3292 A 3459*	High Grade Phosphate. High Grade Phosphate.	(G.† { F.†							
		Yale.....				21.15	3.54	17.61	
A 3459*	High Grade Phosphate.	(G.† { F.†							
		Grand Rapids.....				19.20	1.74	17.46	
A 3459*	High Grade Phosphate.	(G.† { F.†							
		Average.....				20.46	2.17	18.29	

A 3371	Liberty Grain Grower.....	Uly.....	{ G.† F.†	0.13	0.11	0.18	0.41	20.75	10.50	10.00	.....
A 3257	Liberty Wheat and Corn Grower.....	Mt. Clemens.....	{ G.† F.†	0.20	0.08	0.23	0.41	18.70	7.36	8.00	1.00
A 3308	Liberty Wheat and Corn Grower.....	Vassar.....	{ F.†	0.12	0.19	0.34	0.65	20.15	11.02	9.13	1.22
		Average.....		0.16	0.14	0.28	0.58	19.43	9.19	10.24	1.17
A 3347	Michigan Beet and Bean Special.....	Eaton Rapids.....	{ G.† F.†	0.46	0.06	0.22	0.41	15.70	3.38	11.00	1.00
A 3419	Michigan Beet and Bean Special.....	Wayland.....	{ F.†	0.30	0.07	0.28	0.65	16.25	4.44	11.81	1.34
		Average.....		0.38	0.07	0.25	0.70	15.98	3.91	12.07	1.25
A 3372	Nitro Phosphate.....	Uly.....	{ G.† F.†	0.23	0.07	0.15	0.41	18.45	2.48	15.00	.....
A 184*	Potash Special.....	Eaton Rapids.....	{ G.† F.†	.....	.....	.....	.....	11.50	1.48	10.00	2.00
A 3105	Potash Special.....	Charlotte.....	{ F.†	.....	.....	.....	.....	21.55	8.78	10.02	2.15
		Average.....		.....	.....	.....	.....	16.53	5.13	11.40	1.98
A 3601*	Royal Phosphate.....	Minden City.....	{ G.† F.†	.....	.....	.....	.....	19.50	4.32	11.00	.....
A 3458*	Special Manure.....	Grand Rapids.....	{ G.† F.†	0.87	0.13	0.26	0.82	13.88	4.43	10.00	2.00
A 3515*	Special Manure.....	Vermontville.....	{ F.†	0.34	0.16	0.16	1.26	13.70	1.84	9.45	2.67
A 3641*	Special Manure.....	Clayton.....		0.45	0.11	0.27	0.66	12.55	2.64	11.86	1.68
		Average.....		0.55	0.13	0.23	0.91	13.38	2.97	10.41	2.01
A 3222	Special Phosphate Mixture.....	Dundee.....	{ G.† F.†	.....	.....	.....	.....	24.15	12.28	10.00	.....
A 3382	Special Phosphate Mixture.....	Caro.....	{ F.†	.....	.....	.....	.....	23.55	11.12	11.87	.....
A 3420	Special Phosphate Mixture.....	Wayland.....		.....	.....	.....	.....	24.10	11.62	12.43	.....
A 3628*	Special Phosphate Mixture.....	Hudson.....		.....	.....	.....	.....	24.20	10.20	12.48	.....
A 3689*	Special Phosphate Mixture.....	Ruth.....		.....	.....	.....	.....	24.15	12.50	11.65	.....
		Average.....		.....	.....	.....	.....	24.03	11.54	12.49	.....
A 3457*	Standard Meal Mixture.....	Grand Rapids.....	{ G.† F.†	0.51	0.09	0.66	0.82	25.15	12.26	10.00	.....
				.....	.....	.....	0.66	.....	.....	12.89	.....

Abbreviations for Guaranteed and Found.
*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.	
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.	Available.		
Federal Chemical Co.—Con.											
A 2788	Standard Wheat and Corn Mkr.	Blissfield.	{ G.† F.†	0.10	0.10	0.32	0.41	16.28	3.24	11.50	0.50
A 3086	Standard Wheat and Corn Mkr.	Zeeland.	{ F.†	0.20	0.08	0.21	0.49	15.30	3.52	13.04	0.66
A 3221	Standard Wheat and Corn Mkr.	Dundee.		0.18	0.10	0.20	0.48	15.35	3.46	11.78	0.56
A 3516*	Standard Wheat and Corn Mkr.	Vermontville.		0.13	0.10	0.29	0.52	14.70	2.52	12.18	0.50
	Average.			0.15	0.10	0.25	0.50	15.41	3.19	12.22	0.52
A 3690*	Star Phosphate.	Ruth.	{ G.† F.†					15.25	4.00	10.00	0.56
A 3431	Tobacco Formula.	Kalamazoo.	{ G.† F.†	0.07	0.07	0.28	0.41	16.33	8.81	8.00	1.00
							0.42			7.52	0.72
A 148*	Wheat and Corn Special.	Mason.	{ G.† F.†	0.15	0.07	0.20	0.41	14.10	2.40	11.00	1.00
A 2667	Wheat and Corn Special.	Romeo.	{ F.†	0.24	0.08	0.21	0.53	19.28	8.14	11.14	0.98
A 3531*	Wheat and Corn Special.	Grand Ledge.		0.12	0.07	0.20	0.39	19.65	7.80	11.85	1.11
A 3640*	Wheat and Corn Special.	Clayton.		0.18	0.09	0.29	0.56	14.45	3.14	11.31	1.26
	Average.			0.17	0.08	0.23	0.48	16.87	5.37	11.50	1.11
A 2991	Wheat and Grain Special.	Clinton.	{ G.† F.†	0.44	0.09	0.23	0.82	16.80	3.68	12.00	1.00
A 3456*	Wheat and Grain Special.	Grand Rapids.		0.33	0.11	0.33	0.77	15.08	3.62	11.46	1.65
A 3517*	Wheat and Grain Special.	Nashville.		0.36	0.07	0.39	0.82	15.30	3.14	12.16	0.96
A 3614*	Wheat and Grain Special.	Homer.		0.42	0.11	0.26	0.79	14.80	2.64	12.16	1.48
	Average.			0.39	0.10	0.30	0.79	15.50	3.27	12.23	1.27
A 3670	400 Phosphate Mixture.	Oxford.	{ G.† F.†					24.05	12.92	10.00	
A 2831	400 Phosphate Mixture.	Harbor Beach.						24.60	12.68	11.92	
A 2838	400 Phosphate Mixture.	Minden City.						24.60	13.90	10.70	
	Average.							24.42	13.17	11.25	

The Fertilizer Chemical Co., Cleveland, Ohio.									
A 2997	Nitro-Fertilizer.....	{ G.†							\$.00
A 3413	Nitro-Fertilizer.....	{ F.†	2.60	0.00	0.00	3.95	0.00	3.95	3.44
	Battle Creek.....		2.25	0.00	0.00	4.30	0.00	4.30	5.93
	Average.....		2.43	0.00	0.00	2.43	0.00	4.13	4.79
	Line-Fertilizer.....	G.†				0.00	3.00	0.00	0.00
Gleaner Clearing House Association, Detroit, Mich.									
A 3290	14% Acid Phosphate.....	{ G.†						14.00	
	Ammonia and Phosphoric Acid.....	{ F.†				16.95	1.52	15.43	
		G.†				1.65		10.00	
A 3681*	Bean and Corn Grower.....	{ G.†	0.49	0.33	0.23	0.82		10.00	1.00
		{ F.†				11.90	1.80	10.10	1.10
A 3326	General Grower.....	{ G.†	0.42	0.43	0.17	0.82		8.00	1.00
		{ F.†				1.02	9.85	8.21	1.28
	Grain Grower.....	{ G.†	0.89	0.66	0.21	1.65	2.30	8.40	1.00
		{ F.†				10.70		1.27	1.00
A 3636*	Grain Special.....	G.†				1.65		10.00	1.00
A 3289	Phosphoric Acid and Potash.....	{ G.†						10.00	2.00
A 3291	Phosphoric Acid and Potash.....	{ F.†				12.55	1.00	11.55	1.91
A 3328	Phosphoric Acid and Potash.....					11.15	0.84	10.31	1.85
A 3680*	Phosphoric Acid and Potash.....					10.95	0.96	9.99	2.32
						11.40	0.80	10.60	1.72
	Average.....					11.51	0.90	10.61	1.95
A 3324	Wolverine Pride.....	{ G.†	0.47	0.42	0.21	0.82		8.00	2.00
A 3327	Wolverine Pride.....	{ F.†	0.42	0.49	0.20	1.10	1.36	8.84	2.35
						10.20	1.72	8.63	2.30
Holland-St. Louis Sugar Co., Decatur, Ind.									
	Average.....		0.45	0.46	0.20	1.11	1.54	8.74	2.33
A 3182	Victory Brand Beet and Grain Booster.....	{ G.†	0.86	0.07	0.11	0.80		10.00	2.00
A 3409	Victory Brand Beet and Grain Booster.....	{ F.†	0.96	0.07	0.07	1.04	0.46	10.19	2.49
						11.30	0.38	10.92	2.00
	Average.....		0.91	0.07	0.09	1.07	0.42	10.56	2.28
	Victory Brand Mint and Onion Booster.....	G.†				0.80		10.00	8.00

†Abbreviations for Guaranteed and Found.

*All Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.
			Total.				Total.			
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	As Total.	Total.	Insoluble.	Available.	
Independent Packers Fertilizer Co., Columbus, O.										
A 2922	Independent Truck Special.....	{ G.† F.†	0.38	0.13	0.25	0.82	10.35	1.98	8.00	2.00
A 3232	Independent Truck Special.....	{ F.†	0.28	0.15	0.24	0.67	8.88	1.86	7.02	2.34
	Average.....		0.33	0.14	0.25	0.72	9.61	1.92	7.69	3.06
A 3233	No. 1 Independent Favorite.....	{ G.† F.†	0.26	0.06	0.14	0.41	13.10	2.16	10.00	1.00
	Average.....		0.26	0.06	0.14	0.46	13.10	2.16	10.94	0.58
A 2920	No. 2 Bone Meal and Phosphate Mixture.....	{ G.† F.†	0.45	0.36	0.26	0.82	18.30	10.67	8.00	1.00
A 3365*	No. 2 Bone Meal and Phosphate Mixture.....	{ F.†	0.36	0.17	0.27	0.80	17.80	7.98	7.63	1.06
A 3673*	No. 2 Bone Meal and Phosphate Mixture.....		0.14	0.22	0.45	0.81	16.10	2.74	13.36	1.03
	Average.....		0.32	0.25	0.32	0.89	17.40	7.13	10.27	1.01
A 123*	No. 3 Corn, Wheat, Oats & Clover.....	{ G.† F.†	0.15	0.08	0.14	0.41	9.35	1.18	8.00	1.00
A 2799	No. 3 Corn, Wheat, Oats & Clover.....	{ F.†	0.16	0.10	0.29	0.55	10.65	2.10	8.17	0.82
A 2573	No. 3 Corn, Wheat, Oats & Clover.....		0.07	0.08	0.19	0.34	13.40	2.40	11.00	1.25
A 2918	No. 3 Corn, Wheat, Oats & Clover.....		0.23	0.09	0.19	0.51	10.40	1.76	8.64	1.07
A 3329*	No. 3 Corn, Wheat, Oats & Clover.....		0.06	0.08	0.20	0.34	10.65	1.86	8.79	1.04
	Average.....		0.13	0.09	0.20	0.42	10.89	1.86	9.03	0.99
A 3326*	No. 4 Independent Grain Special.....	{ G.† F.†	0.42	0.14	0.17	0.82	8.95	1.12	7.83	4.00
A 3330*	No. 4 Independent Grain Special.....	{ F.†	0.68	0.07	0.15	0.90	10.00	0.62	9.38	3.65
A 3342*	No. 4 Independent Grain Special.....		0.54	0.09	0.20	0.83	9.15	0.41	8.71	4.16
A 3695*	No. 4 Independent Grain Special.....		0.46	0.08	0.16	0.70	9.45	0.56	8.89	3.11
A 3617*	No. 4 Independent Grain Special.....		0.73	0.06	0.12	0.91	9.35	0.80	8.55	3.66
	Average.....		0.56	0.09	0.16	0.81	9.38	0.71	8.67	3.83
A 2872	No. 4 Truck Grower.....	{ G.† F.†	0.28	0.15	0.31	0.82	10.65	1.16	8.00	1.00
A 2921	No. 4 Truck Grower.....	{ F.†	0.52	0.14	0.20	0.86	10.85	1.74	9.49	1.00
A 3224	No. 4 Truck Grower.....		0.35	0.13	0.25	0.73	10.55	2.00	8.55	1.18
A 3231	No. 4 Truck Grower.....		0.27	0.15	0.30	0.72	10.90	1.86	9.04	1.03
	Average.....		0.36	0.14	0.26	0.76	10.74	1.69	9.05	1.08

A 2938 A 3223	No. 5 Universal Crop. No. 3 Universal Crop.	Willis. Dundee.	{ G. F. }	0.41 0.40	0.13 0.11	0.19 0.21	0.82 0.73 0.72	12.85 12.65	2.14 1.86	10.00 10.71 10.79	...............
	Average.....			0.41	0.12	0.20	0.75	12.75	2.00	10.75	.....
A 3118 A 3360*	No. 7 Corn & Wheat Special. No. 7 Corn & Wheat Special.	Illiana. St. Johns.	{ G. F. }	0.73 0.71	0.07 0.12	0.18 0.20	0.82 0.68	9.40 9.40	1.58 1.24	8.00 8.02	..........
A 3089*	No. 7 Corn & Wheat Special.	North Adams.		0.62	0.06	0.15	0.84	8.23	0.78	7.66	1.83
A 3218*	No. 7 Corn & Wheat Special.	Williamston.		0.60	0.05	0.13	0.83	8.25	0.76	7.65	1.87
A 3635*	No. 7 Corn & Wheat Special.	Ottawa Lake.		0.55	0.05	0.15	0.73	9.30	0.48	9.30	1.96
	Average.....			0.58	0.07	0.16	0.81	9.26	0.97	8.29	1.90
A 2798 A 3225 A 3266 A 3288	No. 9 Ammoniated Phosphate. No. 9 Ammoniated Phosphate. No. 9 Ammoniated Phosphate. No. 9 Ammoniated Phosphate.	North Adams. Dundee. Armad. Emmet.	{ G. F. }	0.33 0.53 0.06	0.13 0.10 0.10	0.26 0.22 0.25	0.47 0.37 0.41	11.65 15.05 15.05 15.10	2.14 2.56 1.94 2.34	12.00 12.21 12.69 12.76	....................
	Average.....			0.11	0.12	0.25	0.48	14.96	2.27	12.69	.....
A 121* A 2919 A 2939 A 3280 A 3564	No. 11 High Grade Phosphate. No. 11 High Grade Phosphate. No. 11 High Grade Phosphate. No. 11 High Grade Phosphate. No. 11 High Grade Phosphate.	Capac. Lansing. Willis. Adrian. St. Johns.	{ G. F. }					19.63 19.35 17.90 17.83 18.80	1.34 0.78 1.44 2.00 0.48	16.06 18.29 18.57 16.46 15.83 18.52	.........................
	Average.....							18.70	1.21	17.49	.....
A 2721 A 2950 A 3099 A 3437*	16% Acid Phosphate. 16% Acid Phosphate. 16% Acid Phosphate. 16% Acid Phosphate.	Reading. Carleton. Coopersville. Hudsonville.	{ G. F. }					18.80 19.40 18.95 20.50	1.14 1.62 1.18 1.42	16.00 17.66 17.78 17.77 19.08	....................
	Average.....							19.41	1.34	18.07	.....
A 163* A 2720 A 2989 A 3016 A 3081 A 3460*	18% Acid Phosphate. 18% Acid Phosphate. 18% Acid Phosphate. 18% Acid Phosphate. 18% Acid Phosphate. 18% Acid Phosphate.	Tekonsha. Reading. Tecumseh. Kalamazoo. Grand Rapids. Grand Rapids.	{ G. F. }					21.25 21.15 20.05 19.50 19.45 20.15	0.96 0.66 0.64 0.65 0.74 1.16	18.00 20.29 20.49 19.41 18.84 18.71 18.99	..............................
	Average.....							20.26	0.80	19.46	.....

*Abbreviations for Guarantee and Found.

*Fall Samples.

A 2719 A 3235	Crop Grower..... Crop Grower.....	{ G.† { F.†	0.28 0.31	0.27 0.22	0.21 0.26	0.80 0.76 0.79	9.78 11.00	0.88 0.80	8.00 8.90 10.10	1.00 1.16 0.95
	Average.....		0.30	0.25	0.23	0.78	10.39	0.89	9.50	1.00
A 3095 A 3147	Dissolved Phosphate..... Dissolved Phosphate.....	{ G.† { F.†					16.40 16.35	1.40 1.08	14.00 15.27	
	Average.....						16.38	1.24	15.14	
A 3584* A 3600*	Grain Grower..... Grain Grower.....	{ G.† { F.†	0.32 0.21	0.21 0.24	0.27 0.28	0.80 0.80 0.73	15.10 15.40	1.46 1.86	13.00 13.64 13.54	
	Average.....		0.27	0.22	0.28	0.77	15.25	1.66	13.59	
A 187* A 2718 A 2988 A 3524*	Grain and Grass Grower..... Grain and Grass Grower..... Grain and Grass Grower..... Grain and Grass Grower.....	{ G.† { F.†	0.37 0.27 0.52 0.46	0.31 0.25 0.30 0.23	0.25 0.21 0.30 0.22	0.80 0.93 0.73 1.12 0.91	10.65 10.25 10.90 11.40	2.02 0.88 0.82 2.00	8.00 8.63 9.37 10.08 9.40	2.00 2.15 2.60 2.41 1.95
	Average.....		0.41	0.27	0.24	0.92	10.80	1.43	9.37	2.28
A 2717 A 2940 A 3149 A 3439* A 3533*	Phosphate & Potash..... Phosphate & Potash..... Phosphate & Potash..... Phosphate & Potash..... Phosphate & Potash.....	{ G.† { F.†					13.25 13.75 12.95 16.23 15.75	0.81 0.90 0.82 1.46 1.86	12.00 12.41 12.85 12.13 14.77 13.89	2.00 2.38 1.98 2.00 2.19 2.12
	Average.....						14.39	1.18	13.21	2.13
A 185* A 3080 A 3587* A 3684*	Two Eight Two..... Two Eight Two..... Two Eight Two..... Two Eight Two.....	{ G.† { F.†	0.85 0.53 0.44 0.93	0.53 0.66 0.78 0.35	0.28 0.44 0.23 0.32	1.00 1.66 1.63 1.45 1.60	11.75 8.60 9.25 10.60	2.46 0.60 0.70 2.04	8.00 9.29 8.00 8.55 8.56	2.00 2.42 2.03 2.03 1.94
	Average.....		0.69	0.58	0.32	1.59	10.05	1.45	8.60	2.03
A 162* A 3583* A 3622* A 3646*	Acid Phosphate..... Acid Phosphate..... Acid Phosphate..... Acid Phosphate.....	{ G.† { F.†					19.25 19.25 18.05 18.35	2.36 1.84 1.84 1.92	16.00 16.89 17.41 16.21 16.43	
	Average.....						18.73	1.99	16.74	

†Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Insoluble.	Available.	
I. A. C. Brands.—Continued.									
A 3693*	Alkaline.....	Memphis..... { G.† F.†						10.60 10.86	4.00 3.70
A 3807*	Animal Brand.....	Zeeland..... { G.† F.†	1.81	0.51	0.50	2.80 2.62	2.40	10.60 9.95	.....
A 3551*	Complete.....	Kent City..... { G.† F.†	0.88	0.39	0.38	1.60 1.65		8.00 8.23	2.00
A 3625*	Complete.....	Hudson..... { G.† F.†	0.78	0.43	0.40	1.61		8.42	2.02
A 3643*	Complete.....	Clayton..... { G.† F.†	0.82	0.41	0.39	1.62		7.89	2.04
A 3812*	Complete.....	Greenville..... { G.† F.†	0.85	0.38	0.21	1.44	9.20	7.07	1.75
	Average.....		0.83	0.40	0.35	1.58	10.60	7.90	1.99
A 161*	Corn & Grain.....	Marshall..... { G.† F.†	0.53	0.29	0.16	1.80 0.98		12.00 12.39	.....
A 3806*	Corn & Grain.....	Zeeland..... { G.† F.†	0.52	0.32	0.07	0.91		11.37	.....
A 3813*	Corn & Grain.....	Greenville..... { G.† F.†	0.59	0.33	0.25	1.15	14.50	11.25	.....
	Average.....		0.55	0.31	0.15	1.01	14.27	11.68	.....
A 160*	Crop Producer.....	Marshall..... { G.† F.†	0.56	0.31	0.21	1.00 1.08		12.00 11.90	2.00 2.04
A 3700*	Early Harvest.....	Utica..... { G.† F.†	0.77	0.45	0.35	1.60 1.57		10.00 10.05	.....
A 3805*	Early Harvest.....	Zeeland..... { G.† F.†	0.80	0.39	0.33	1.52		10.25	.....
A 3808*	Early Harvest.....	Greenville..... { G.† F.†	0.76	0.40	0.27	1.43	13.55	10.57	.....
	Average.....		0.78	0.41	0.32	1.51	13.03	10.28	.....
A 3810*	General Crop.....	Greenville..... { G.† F.†	0.11	0.30	0.14	0.80 0.88	2.40	10.80	.....
A 3624*	Steamed Bone.....	Hudson..... { G.† F.†	0.11	0.45	0.31	0.80 0.87	27.60	.....	.....

A 3321* A 3343* A 3359*	Ten Two. Ten Two. Ten Two.	Hudson. Clayton. Greenville.	{ G.† { F.*	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	10.00 11.54 10.44 11.25	2.00 1.94 2.46 2.43
A 3582* A 3623* A 3634* A 3511*	Victory. Victory. Victory. Victory.	Kent City. Hudson. Clayton. Greenville.	{ G.† { F.*	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....
A 139* A 138*	Wheat Special. Wheat Special.	Marshall. Hillsdale.	{ G.† { F.*	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....
Jarecki Chemical Co., Sandusky, O.											
A 189* A 2740 A 2781 A 2792 A 3049 A 3144*	Acid Phosphate. Acid Phosphate. Acid Phosphate. Acid Phosphate. Acid Phosphate. Acid Phosphate.	Reading. Albion. Blissfield. Erie. Decor. Coopersville.	{ G.† { F.*	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....	..... ..... ..... ..... ..... .....
A 2924 A 2955 A 3045 A 3051 A 3446*	Ammoniated Phosphate. Ammoniated Phosphate. Ammoniated Phosphate. Ammoniated Phosphate. Ammoniated Phosphate.	Milan. Carleton. Hudsonville. Decor. Coopersville.	{ G.† { F.*	..... ..... ..... ..... .....	..... ..... ..... ..... .....	..... ..... ..... ..... .....	..... ..... ..... ..... .....	..... ..... ..... ..... .....	..... ..... ..... ..... .....	..... ..... ..... ..... .....	..... ..... ..... ..... .....
A 3440*	Clay Soil Special.	Hudsonville.	{ G.† { F.*	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....
A 2713 A 2916 A 2931 A 3442*	C. O. D. Phosphate. C. O. D. Phosphate. C. O. D. Phosphate. C. O. D. Phosphate.	Reading. Inkster. Willis. Coopersville.	{ G.† { F.*	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....	..... ..... ..... .....
Average.....											

†Abbreviations for Guaranteed and Found.
*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Insoluble.	Available.	
A 190* A 2714 A 2789 A 2746 A 3071 A 3129 A 3513*	Jarecki Chemical Co.—Con.	{ G.† { F.†	0.60	0.00	0.07	0.82	.....	11.00	1.00
		Reading.....	0.47	0.16	0.07	0.73	13.90	1.20	12.70
		Reading.....	0.47	0.16	0.18	0.81	13.05	1.82	11.23
		Albion.....	0.41	0.15	0.22	0.84	13.35	1.86	11.49
		Hudson.....	0.47	0.12	0.20	0.79	12.90	1.72	11.18
		Lake Erie Guano with Phosphate and Potash.....	0.50	0.21	0.13	0.90	15.30	1.50	13.80
		Lake Erie Guano with Phosphate and Potash.....	0.51	0.14	0.13	0.79	14.20	2.34	11.86
		Alma.....	0.43	0.20	0.22	0.85	13.65	2.53	11.12
		Dutton.....	0.43	0.20	0.22	0.85	13.65	2.53	11.12
		Average.....	0.50	0.14	0.17	0.81	13.48	1.85	11.63
A 2747 A 2782 A 2851 A 2893 A 3043 A 3118 A 3128 A 3445*	Jarecki Chemical Co.—Con.	{ G.† { F.†	0.38	0.07	0.14	0.59	.....	10.00	1.00
		Hudson.....	0.38	0.07	0.14	0.59	.....	10.00	1.00
		Blissfield.....	0.23	0.06	0.16	0.45	12.40	1.62	10.78
		Stark.....	0.23	0.07	0.15	0.45	11.90	1.04	10.86
		Waltz.....	0.24	0.09	0.15	0.48	12.45	2.14	10.31
		Hudsonville.....	0.21	0.07	0.11	0.40	12.40	2.16	10.27
		Saranac.....	0.23	0.09	0.12	0.46	13.10	2.02	10.48
		Alma.....	0.24	0.05	0.09	0.38	12.25	1.92	10.33
		Coopersville.....	0.31	0.07	0.10	0.48	13.05	1.26	11.79
		Average.....	0.31	0.07	0.13	0.51	12.51	1.78	10.73
A 3443* A 3620* A 3655*	Middle West Formula.	{ G.† { F.†	1.07	0.24	0.17	1.48	.....	12.00	2.00
		Coopersville.....	1.07	0.24	0.17	1.48	.....	12.00	2.00
		Hudson.....	1.23	0.11	0.11	1.55	14.18	3.98	10.20
		Erie.....	1.23	0.22	0.13	1.60	14.45	2.02	12.43
		Average.....	1.22	0.19	0.13	1.54	13.00	3.63	11.37
A 2954	Raw Bone and Phosphate Mixture.	{ G.† { F.†	0.50	0.14	0.17	0.81	.....	8.00	1.00
		Carleton.....	0.50	0.14	0.17	0.81	.....	8.00	1.00
A 3182 A 3175	Special Sugar Beet Grower.	{ G.† { F.†	0.42	0.11	0.10	0.63	.....	10.00	1.00
		Baroda.....	0.27	0.07	0.11	0.45	.....	11.72	1.10
	Average.....		0.35	0.09	0.10	0.54	.....	11.06	0.83
			0.35	0.09	0.10	0.54	.....	11.39	0.97

A 2852	Square Brand Phosphate and Potash.....	(G.†				13.10	2.92	10.00	2.00
A 2992	Clinton.....	{F.†				12.55	2.18	10.18	1.42
A 3044	Square Brand Phosphate and Potash.....					13.80	2.43	10.37	1.68
A 3050	Hudsonville.....					12.70	1.30	11.48	1.90
A 3659*	Square Brand Phosphate and Potash.....					12.20	1.52	10.68	1.60
	Average.....					12.87	2.05	10.82	1.72
A 3489*	Superphosphate and Potash.....	(G.†				12.95	1.80	10.00	4.00
A 3536*	Lake Odessa.....	{F.†				11.75	1.32	11.15	3.22
	Average.....					12.35	1.56	10.79	2.73
A 191*	Tobacco and Truck Grower.....	(G.†				0.82		8.00	2.00
A 2741	Tobacco and Truck Grower.....	{F.†	0.50	0.12	0.19	10.65	1.50	9.15	1.95
A 2748	Albion.....		0.55	0.11	0.24	9.80	1.40	8.95	2.03
A 2791	Tobacco and Truck Grower.....		0.40	0.16	0.35	9.80	1.22	8.58	2.01
A 2917	Tobacco and Truck Grower.....		0.33	0.17	0.29	10.90	1.64	8.26	2.03
A 3174	Tobacco and Truck Grower.....		0.69	0.08	0.17	9.90	0.94	8.56	1.98
A 3441*	Tobacco and Truck Grower.....		0.49	0.09	0.19	10.40	0.83	9.32	1.75
A 3512*	Tobacco and Truck Grower.....		0.55	0.12	0.30	9.80	1.68	8.12	2.98
	Dutton.....		0.33	0.19	0.12	10.65	1.04	9.61	1.75
	Average.....		0.48	0.13	0.22	10.31	1.29	9.02	1.95
Morris & Company, Chicago, Ill.									
	Big Two Bone Meal.....	G.†				2.00			
	Big Four.....	G.†				3.29		7.00	6.50
A 3592*	Big Ten Manure and Potash.....	(G.†	0.18	0.99	0.47	1.65	0.98	8.00	2.00
	Special Big Three.....	{F.†				11.65		10.67	1.74
	Special Big Four Half and Half.....	G.†				0.41		11.00	3.90
	Special Big Seven Done Meal.....	G.†				0.41		13.00	
	Special Big Nine Manure and Potash.....	G.†				0.82			
	Special Big Twelve Phosphated Manure.....	G.†				0.41		11.00	1.00
National Plant Food Co., Eau Claire, Wis.									
A 2996	Red Snapper Plant Food.....	(G.†	1.24	1.96	1.77	5.00		4.00	1.95
A 3003	Red Snapper Plant Food.....	{F.†	1.18	2.30	1.67	4.97	7.28	6.47	1.54
	Average.....		1.21	2.13	1.72	5.15	7.20	6.40	1.40
						5.06	7.24	6.44	1.47

†Abbreviations for Guaranteed and Found.
*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.			Potash.	
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.		Available.
A 3146	Natural Guano Co., Aurora, Ill. Sheeps Head Pulverized Sheep Manure..... Nitrate Agencies Co., Columbus, Ohio. NaCo Nitrate of Soda..... Pacific Manure & Fertilizer Co., San Francisco, Calif.	Grand Rapids..... G.†	0.94	0.60	1.23	2.25 2.77	1.85	0.18	1.00 1.67	1.50 2.22
A 3210 A 3211 A 3235	Groz-it Brand Fertilizer..... Groz-it Brand Fertilizer..... Groz-it Brand Fertilizer.....	Detroit..... Detroit..... Pontiac..... Average.....	0.43 0.39 0.37	0.43 0.45 0.41	0.97 1.01 0.78	1.50 1.82 1.85 1.56	1.00 1.00 1.00	0.22 0.18 0.16	0.75 0.78 0.82 0.84	2.50 3.03 3.07 2.12
A 2831 A 3249 A 3695*	Packers Fertilizer Co., Sandusky, Ohio. Acid Phosphate..... Acid Phosphate..... Acid Phosphate.....	Ruth..... Deerfield..... Deerfield..... Average.....	0.40	0.43	0.92	1.75	1.00	0.19	0.81	2.74
A 3690 A 3114	Acidulated Phosphate..... Acidulated Phosphate.....	Zeeland..... Holland..... Average.....					18.20 18.40 18.05	1.78 0.58 0.42	16.42 17.82 17.63	
A 2936 A 3572*	Alkaline Phosphate..... Alkaline Phosphate and Potash.....	Willis..... Carson City..... Average.....					18.22	0.93	17.29	
A 3579* A 3603*	Clay Soil Special..... Clay Soil Special.....	Carson City..... Deerfield..... Average.....	1.30 1.09	6.17 0.17	0.67 0.08	1.65 1.54 1.34	13.05 11.55	2.72 0.70	16.67 16.47	2.00 1.55 3.79
							18.40	1.83	16.57	2.67
									16.00 19.33 16.85	
									12.00 13.61 12.04	
							12.30	1.71	10.59	
									12.00 14.55 14.00	
									12.83	

A 3557* A 2935 A 3112 A 3367*	Favorite Grain Grower..... Favorite Grain Grower..... Favorite Grain Grower..... Favorite Grain Grower.....	{ G.† (F.†	0.64 0.51 0.57 0.48	0.19 0.15 0.12 0.18	0.18 0.14 0.10 0.17	0.82 1.01 0.80 0.79 0.83	13.15 13.49 13.95 12.20	2.91 3.62 4.32 1.98	10.00 10.24 10.28 10.22	....................
	Average.....		0.55	0.16	0.15	0.86	13.30	2.23	11.07	.....
A 2937 A 2957 A 2974 A 3030 A 3115	O. K. Fertilizer..... O. K. Fertilizer..... O. K. Fertilizer..... O. K. Fertilizer..... O. K. Fertilizer.....	{ G.† (F.†	0.24 0.27 0.36 0.26 0.29	0.08 0.08 0.06 0.10 0.07	0.13 0.10 0.11 0.08 0.19	0.41 0.45 0.53 0.44 0.46	14.25 13.50 11.85 12.65 12.85	2.34 5.42 1.16 1.20 1.94	10.00 11.91 10.08 10.69 11.45 10.91	1.00 0.95 0.97 1.15 0.98 0.96
	Average.....		0.28	0.08	0.19	0.46	13.92	2.01	11.01	1.00
A 2956 A 3091 A 3141 A 3360*	Phosphate with Humus..... Phosphate with Humus..... Phosphate with Humus..... Phosphate with Humus.....	{ G.† (F.†	0.16 0.27 0.26 0.27	0.09 0.07 0.05 0.08	0.12 0.04 0.10 0.06	0.41 0.37 0.48 0.41	14.60 14.80 13.15 14.70	2.42 1.90 2.34 2.62	12.00 12.18 12.90 12.81 12.08	.........................
	Average.....		0.24	0.19	0.08	0.42	14.81	2.32	12.49	.....
A 3187 A 3190	Potato Tobacco and Truck Grower..... Potato Tobacco and Truck Grower.....	{ G.† (F.†	0.52 0.51	0.11 0.11	0.20 0.18	0.83 0.80	10.20 10.65	1.02 1.12	9.18 9.52	2.00 1.79 1.85
	Average.....		0.52	0.11	0.19	0.82	10.43	1.07	9.36	1.82
A 2969 A 3104*	Pure Bone with Phosphate..... Pure Bone with Phosphate.....	{ G.† (F.†	0.53 0.63	0.12 0.14	0.15 0.13	0.80 0.90	17.00 17.20	8.90 8.92	8.10 8.28	1.00 1.22 0.84
	Average.....		0.58	0.13	0.14	0.85	17.10	8.91	8.19	1.03
A 3541* A 3371*	Quality Brand..... Quality Brand.....	{ G.† (F.†	1.37 1.45	0.14 0.10	0.10 0.05	1.61 1.69	14.40 12.33	0.66 1.83	13.74 10.50	2.00 1.98 1.89
	Average.....		1.41	0.12	0.05	1.61	13.37	1.25	12.12	1.94
A 3578* A 3375*	Superphosphate and Potash..... Superphosphate and Potash.....	{ G.† (F.†	..... .....	..... .....	..... .....	..... .....	11.55 10.45	0.54 0.50	11.01 9.45	4.00 3.00 3.65
	Average.....		.....	.....	.....	.....	11.00	0.52	10.48	3.48

Abbreviations for Guaranteed and Found.

*Full Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Total.	Phosphoric Acid.		Potash.	
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.		Total.	Insoluble.		Available.
Packers Fertilizer Co.—Con.										
A 2758	Sweepstakes.....	{ G.† F.†	0.45	0.16	.....	0.82	13.40	1.28	11.00	1.00
A 3189	Sweepstakes.....	{ F.†	0.43	0.12	0.20	0.75	14.00	1.72	12.28	1.16
A 3403*	Sweepstakes.....	Holland.....	0.51	0.16	0.21	0.88	13.85	2.80	11.05	1.13
A 3540*	Sweepstakes.....	Lake Odessa.....	0.50	0.18	0.23	0.91	13.88	2.86	11.02	0.96
	Average.....		0.47	0.16	0.20	0.83	13.80	2.13	11.62	1.12
Parke Davis & Co., Detroit, Mich.										
	Parkdale Fertilizer.....	G.†	.....	.....	.....	6.00	.....	.....	0.40	1.50
Pulverized Manure Co., Chicago, Illinois.										
A 3075	Wizard Brand Cattle Manure.....	{ G.† F.†	0.30	0.33	0.93	1.80	0.90	0.18	1.00	1.00
A 3254	Wizard Brand Mixed Manure.....	{ G.† F.†	0.30	0.46	0.97	1.80	1.55	0.34	1.21	1.49
A 2965	Wizard Brand Sheep Manure.....	{ G.† F.†	0.21	0.40	0.88	1.80	1.75	0.78	1.00	1.00
A 3074	Wizard Brand Sheep Manure.....	{ F.†	0.30	0.53	1.21	2.04	1.30	0.18	0.97	2.01
	Average.....		0.26	0.47	1.04	1.77	1.53	0.48	1.05	2.48
Queen City Fertilizer Co., Sandusky, Ohio.										
3131	Special Sugar Beet Grower.....	{ G.† F.†	0.48	0.19	0.12	0.82	10.05	1.14	8.00	1.00
F. S. Royster Guano Co., Toledo, Ohio.										
A 2916	11% Acid Phosphate.....	{ G.† F.†	.....	.....	.....	.....	16.35	2.28	14.00	.....
A 3322	11% Acid Phosphate.....	{ F.†	.....	.....	.....	.....	13.88	1.64	12.24	.....
A 3546*	14% Acid Phosphate.....	Pangrove.....	.....	.....	.....	.....	16.15	1.06	14.49	.....
A 3666*	14% Acid Phosphate.....	Conklin.....	.....	.....	.....	.....	16.70	1.44	15.26	.....
	Average.....		.....	.....	.....	.....	15.77	1.76	14.01	.....
Alrite Ammoniated Phosphate.										
A 3482*	Alrite Ammoniated Phosphate.....	{ G.† F.†	1.00	0.31	0.22	1.65	14.20	1.98	12.22	.....
A 3487*	Alrite Ammoniated Phosphate.....	Holland.....	0.71	0.23	0.14	1.10	13.00	2.09	10.91	.....
	Average.....		0.86	0.28	0.18	1.32	13.60	2.04	11.56	.....

A 3021	Black Soil Guano.....	{ G.†	0.38	0.20	0.21	0.82	10.15	3.07	7.08	5.00
A 3033	Black Soil Guano.....	{ F.†	0.35	0.19	0.23	0.79	10.55	2.91	7.64	4.44
A 3203	Black Soil Guano.....		0.45	0.19	0.19	0.77	9.80	1.46	8.34	5.06
A 3483*	Black Soil Guano.....		0.37	0.18	0.17	0.83	11.85	4.00	7.85	4.52
A 3509*	Black Soil Guano.....		0.35	0.18	0.27	0.80	11.75	2.72	9.03	4.12
	Average.....		0.38	0.19	0.21	0.78	10.82	2.83	7.99	4.41
A 175*	Cloverdale Potash Mixture.....	{ G.†							10.00	2.00
A 2899	Cloverdale Potash Mixture.....	{ F.†							10.93	1.66
A 2935	Cloverdale Potash Mixture.....						11.55	0.62	9.69	1.67
A 2940	Cloverdale Potash Mixture.....						11.65	1.96	9.22	1.67
A 3024	Cloverdale Potash Mixture.....						11.53	2.31	10.26	1.67
A 3258	Cloverdale Potash Mixture.....						12.25	1.99	9.32	1.77
A 3547*	Cloverdale Potash Mixture.....						11.38	2.06	10.13	1.78
A 3570*	Cloverdale Potash Mixture.....						12.15	2.02	8.98	1.75
	Average.....						11.30	2.32	10.08	1.71
							12.10	2.02		
	Average.....						11.74	1.91	9.83	1.77
A 174*	Cuckoo Crop Guano.....	{ G.†							8.00	1.00
A 2828	Cuckoo Crop Guano.....	{ F.†	0.53	0.18	0.02	0.82	8.95	0.92	8.03	0.94
A 2857	Cuckoo Crop Guano.....		0.29	0.21	0.23	0.73	9.33	1.84	7.41	0.80
A 2844	Cuckoo Crop Guano.....		0.28	0.21	0.25	0.74	9.53	1.85	7.68	0.85
A 3394	Cuckoo Crop Guano.....		0.25	0.21	0.27	0.79	9.78	2.06	7.72	0.94
A 3410	Cuckoo Crop Guano.....		0.52	0.19	0.16	0.87	8.85	1.34	7.51	0.81
A 3503*	Cuckoo Crop Guano.....		0.32	0.17	0.21	0.75	9.15	1.63	7.55	0.97
A 3552*	Cuckoo Crop Guano.....		0.33	0.16	0.12	0.61	9.45	1.46	7.91	1.10
A 3638*	Cuckoo Crop Guano.....		0.34	0.16	0.11	0.81	9.73	2.47	7.30	1.18
A 3656*	Cuckoo Crop Guano.....		0.38	0.17	0.08	0.83	9.45	2.38	7.65	0.97
	Average.....		0.32	0.12	0.10	0.74	8.95	0.76	8.10	1.08
			0.41	0.18	0.17	0.76	9.32	1.67	7.65	0.97
A 2785	Dependo Grain Guano.....	{ G.†							13.00	0.50
A 2848	Dependo Grain Guano.....	{ F.†	0.69	0.13	0.18	0.41	15.65	2.59	13.13	0.44
A 3068	Dependo Grain Guano.....		0.08	0.12	0.22	0.42	14.90	2.49	12.41	0.55
A 3116	Dependo Grain Guano.....		0.17	0.13	0.15	0.45	12.65	2.34	13.11	0.48
A 3388	Dependo Grain Guano.....		0.08	0.11	0.21	0.40	13.80	2.94	12.16	0.55
A 3398	Dependo Grain Guano.....		0.10	0.11	0.17	0.38	13.75	2.28	11.17	0.43
A 3398*	Dependo Grain Guano.....		0.07	0.10	0.15	0.32	14.53	2.43	12.10	0.50
A 3650*	Dependo Grain Guano.....		0.17	0.15	0.12	0.44	14.55	2.43	12.85	0.63
	Average.....		0.20	0.12	0.17	0.49	14.93	2.37	12.56	0.48
A 3580*	Fifty Fifty Bone & Phosphate.....	{ G.†							99.00	
		{ F.†	0.43	0.43	0.33	1.32	22.00	8.98	13.02	

†Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.	Available.	
F. S. Royster Guano Co., Toledo, Ohio.—Con.										
A 181*	Fish Flesh and Fowl Guano.	(G.†)				1.65			8.00	3.00
A 2932	Fish Flesh and Fowl Guano.	{ F.†	0.97	0.21	0.32	1.53	11.10	1.44	9.66	3.03
A 2937	Fish Flesh and Fowl Guano.	Wills.	0.96	0.18	0.24	1.38	9.63	2.84	6.79	2.71
A 3042	Fish Flesh and Fowl Guano.	Yashanti.	0.88	0.17	0.27	1.32	9.90	2.45	7.45	2.44
A 3172	Fish Flesh and Fowl Guano.	Kalamazoo.	1.05	0.20	0.21	1.46	9.25	2.41	6.84	2.75
A 3177	Fish Flesh and Fowl Guano.	Savoy.	0.92	0.17	0.20	1.29	9.35	1.96	7.39	2.70
A 3250*	Fish Flesh and Fowl Guano.	Declar.	0.97	0.17	0.20	1.34	9.40	1.28	8.12	1.88
	Average.....		0.96	0.19	0.24	1.39	9.77	2.06	7.71	2.60
A 2937	Flamingo Ammoniated Phosphate.	(G.†)				2.66			12.00	
A 2847	Flamingo Ammoniated Phosphate.	{ F.†	1.35	0.48	0.33	2.16	14.13	2.52	11.61	
A 3175	Flamingo Ammoniated Phosphate.	Plymouth.	1.45	0.36	0.30	2.11	15.40	2.50	12.90	
A 3428	Flamingo Ammoniated Phosphate.	Savoy.	1.50	0.36	0.23	2.09	13.80	2.32	11.48	
	Kalamazoo.		1.46	0.43	0.30	2.19	13.90	2.40	11.50	
	Average.....		1.44	0.41	0.29	2.14	14.31	2.44	11.87	
A 2768	Ground Bone Meal	(G.†)				0.82	29.00			
A 3202	Ground Bone Meal	{ F.†	0.38	0.99	0.26	1.63	20.80			
A 3333*	Ground Bone Meal	Adrian.	0.82	1.22	0.51	2.56	75.15			
		Clayton.	0.31	0.92	0.33	1.56	78.18			
	Average.....		0.51	1.04	0.37	1.92	57.71			
A 1987	Half and Half Wheat Guano.	(G.†)				0.41			8.00	0.50
A 2845	Half and Half Wheat Guano.	{ F.†	0.03	0.15	0.23	0.41	9.20	1.32	7.88	0.48
A 2870	Half and Half Wheat Guano.	Wayne.	0.00	0.14	0.23	0.37	9.50	1.70	8.10	0.54
A 3115	Half and Half Wheat Guano.	Holland.	0.08	0.14	0.20	0.42	10.40	2.04	8.36	0.49
A 3260	Half and Half Wheat Guano.	Fairchild.	0.07	0.13	0.19	0.39	9.90	1.81	8.06	0.45
A 3267	Half and Half Wheat Guano.	Arnold.	0.04	0.12	0.22	0.42	9.23	1.69	7.54	0.52
	Average.....		0.04	0.17	0.25	0.46	10.65	1.82	8.23	0.47
A 178*	Harmony Potash Mixture.	(G.†)				0.41			8.03	0.49
A 192*	Harmony Potash Mixture.	{ F.†								
A 2858	Harmony Potash Mixture.	Jonesville.					14.00	1.00	12.00	2.00
		Beach.					13.45	1.54	11.91	2.92
							13.58	2.21	11.37	1.90

A 2955*	Harmony Potash Mixture.....	Ypsilanti Conklin.....							14.13 14.30	2.09 2.04	12.04 12.26	1.09 1.96
A 3545*	Harmony Potash Mixture.....	Average.....							13.89	1.77	12.12	1.93
A 1938	High Grade 16% Acid Phosphate.....	{ G.† F.†							16.00		16.00	
A 2000	High Grade 16% Acid Phosphate.....								18.43	2.04	16.39	
A 2608	High Grade 16% Acid Phosphate.....								17.93	3.01	14.97	
A 2827	High Grade 16% Acid Phosphate.....								18.20	2.50	15.70	
A 2836	High Grade 16% Acid Phosphate.....								18.68	2.60	15.46	
A 2856	High Grade 16% Acid Phosphate.....								18.85	2.80	16.05	
A 2869	High Grade 16% Acid Phosphate.....								19.10	2.18	16.92	
A 3489	High Grade 16% Acid Phosphate.....								17.50	0.32	17.18	
	Average.....								18.30	2.21	16.09	
A 2732	Meteor Ammoniated Phosphate.....	{ G.† F.†							12.00		12.00	
A 2736	Meteor Ammoniated Phosphate.....		0.34	0.25	0.91	0.82			11.40	1.92	12.48	
A 3548*	Meteor Ammoniated Phosphate.....		0.45	0.31	0.25	1.04			14.75	2.87	11.87	
A 3551*	Meteor Ammoniated Phosphate.....		0.52	0.33	0.23	1.08			13.25	2.97	11.87	
	Average.....		0.38	0.25	0.15	0.79			13.90	2.16	11.74	
A 2893	Old Glory Potash Mixture.....	{ G.† F.†	0.43	0.28	0.22	0.93			14.33	2.31	12.02	
A 2945	Old Glory Potash Mixture.....								10.50	1.18	10.00	1.09
A 3023	Old Glory Potash Mixture.....								10.93	1.23	9.32	0.87
A 3304	Old Glory Potash Mixture.....								11.60	1.58	9.70	0.83
A 3356	Old Glory Potash Mixture.....								11.85	2.92	10.02	0.85
A 3544*	Old Glory Potash Mixture.....								12.47	1.74	10.73	0.92
	Average.....								11.70	1.44	10.26	1.19
A 2846	Penguin Ammoniated Phosphate.....	{ G.† F.†							11.51	1.53	9.98	0.96
A 3078	Penguin Ammoniated Phosphate.....		1.04	0.26	0.20	1.65			11.50	1.81	10.60	
A 3117	Penguin Ammoniated Phosphate.....		1.13	0.26	0.20	1.50			11.65	2.00	9.69	
A 3429	Penguin Ammoniated Phosphate.....		0.19	0.00	0.00	1.39			11.85	1.86	9.65	
	Average.....		1.02	0.35	0.13	0.19			11.73	1.86	9.49	1.08
			0.85	0.22	0.13	1.20			11.68	1.97	9.71	

† Abbreviations for Guaranteed and Found.

* Full Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.		Potash.	
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Phosphoric Acid.		
								Total.		Insoluble.	Available.
F. S. Royster Guano Co., Toledo, Ohio.—Con.										
A 140*	Special Fish Guano.	Springport.	0.55	0.20	0.12	0.87	11.20	3.64	11.00	2.00
A 145*	Special Fish Guano.	Rivers Junction.	0.48	0.18	0.11	0.77	13.45	1.76	10.69	2.26
A 170*	Special Fish Guano.	Joposville.	0.52	0.13	0.12	0.77	13.00	1.76	11.88	1.94
A 182*	Special Fish Guano.	Hillsdale.	0.55	0.15	0.09	0.79	14.20	1.16	13.04	2.15
A 3070*	Special Fish Guano.	Grand Rapids.	0.41	0.13	0.05	0.59	13.70	2.34	11.36	1.91
A 3171*	Special Fish Guano.	Stevensville.	0.76	0.20	0.11	1.07	12.45	2.00	10.45	1.72
A 3220*	Special Fish Guano.	Monroe.	0.65	0.24	0.18	1.07	12.05	1.70	10.35	1.87
A 3505*	Special Fish Guano.	Me Cords.	0.51	0.13	0.16	0.80	13.80	1.80	12.00	2.20
Average.			0.55	0.17	0.12	0.84	13.37	1.94	11.43	2.04
Eaton Rapids.										
A 120*	Sterling Wheat Guano.	Springport.	1.18	0.38	0.04	1.60	13.68	1.57	12.11	2.00
A 130*	Sterling Wheat Guano.	Joposville.	1.17	0.23	0.22	1.62	13.45	1.58	11.87	1.95
A 180*	Sterling Wheat Guano.	Nunda.	1.29	0.33	0.17	1.56	12.40	0.92	11.48	2.01
A 2170*	Sterling Wheat Guano.	Albion.	1.17	0.22	0.24	1.63	13.80	1.54	12.51	2.16
A 2181*	Sterling Wheat Guano.	Me Cords.	0.99	0.22	0.17	1.38	13.60	1.36	12.24	2.20
Average.			1.16	0.25	0.18	1.59	13.50	1.42	12.08	2.05
Eaton Rapids.										
A 131*	Wheat, Oats and Barley Guano.	Mason.	0.46	0.15	0.12	0.82	9.90	2.66	8.00	2.00
A 153*	Wheat, Oats and Barley Guano.	Quincy.	0.56	0.15	0.09	0.73	9.88	2.51	7.37	2.11
A 170*	Wheat, Oats and Barley Guano.	Willis.	0.46	0.19	0.04	0.69	9.80	1.98	8.52	1.68
A 2034	Wheat, Oats and Barley Guano.	Ypsilanti.	0.42	0.17	0.24	0.83	9.80	2.09	7.71	1.32
A 2068	Wheat, Oats and Barley Guano.	Stevensville.	0.38	0.16	0.18	0.72	12.78	2.12	10.66	1.93
A 3172	Wheat, Oats and Barley Guano.	Me Cords.	0.44	0.22	0.20	0.86	10.70	1.90	8.80	1.73
A 3506*	Wheat, Oats and Barley Guano.	Deatur.	0.35	0.16	0.12	0.63	9.95	1.66	8.29	1.85
A 3511*	Wheat, Oats and Barley Guano.	Deatur.	0.37	0.21	0.14	0.72	10.30	1.80	8.50	2.05
Average.			0.39	0.18	0.15	0.72	10.39	2.00	8.39	1.83
Portage.										
A 3019	Wonder Worker Guano.	Benton Harbor.	0.87	0.18	0.23	0.82	11.25	2.30	8.00	3.00
A 3165	Wonder Worker Guano.	Kalamazoo.	0.33	0.22	0.26	1.28	8.95	0.98	8.95	2.64
A 3430	Wonder Worker Guano.	Kalamazoo.	0.73	0.18	0.26	1.17	9.28	1.60	7.68	1.73
A 3435	Wonder Worker Guano.	Kalamazoo.	0.63	0.16	0.22	1.01	9.63	1.76	7.87	2.08

A 3575*	Wonder Worker Guano.....	0.53	0.16	0.11	0.80	10.95	3.27	7.68	2.77
A 3647*	Wonder Worker Guano.....	0.31	0.20	0.28	0.79	10.15	1.72	8.43	2.68
	Average.....	0.57	0.18	0.23	0.98	10.04	1.94	8.10	2.45
A 2787	Yankee Potash Mixture.....							12.00	1.00
A 3387	Yankee Potash Mixture.....					14.73	1.76	12.97	0.95
A 3549*	Yankee Potash Mixture.....					13.25	0.51	12.71	0.82
	Average.....					13.43	1.44	11.99	1.17
Smith Agricultural Chemical Co., Columbus, Ohio.									
A 2725	16% Acid Phosphate.....					13.80	1.24	12.56	0.98
A 2823	16% Acid Phosphate.....							16.00	
A 2869	16% Acid Phosphate.....					17.85	1.48	16.37	
A 2889	16% Acid Phosphate.....					18.15	1.32	16.33	
A 3473*	16% Acid Phosphate.....					17.75	1.32	16.43	
	Average.....					17.95	1.46	15.96	
	Reading.....					18.40	1.34	17.06	
	Bad Ave.....								
	Wayne.....								
	Walz.....								
	Nunica.....								
	Average.....					18.02	1.58	16.44	
A 2775	Ammoniated Phosphate and Potash.....	0.15	0.11	0.27	0.41	9.27	1.26	8.01	1.06
A 2824	Ammoniated Phosphate and Potash.....	0.00	0.10	0.27	0.53	10.10	1.30	8.80	1.05
A 3101	Ammoniated Phosphate and Potash.....	0.11	0.08	0.19	0.37	8.08	1.26	6.82	1.16
A 3284	Ammoniated Phosphate and Potash.....	0.01	0.17	0.17	0.38	10.40	1.28	9.12	1.03
	Average.....	0.08	0.11	0.22	0.41	8.50	1.22	7.28	1.00
A 3471*	Climax Phosphate.....							10.00	4.00
A 2890	General Crop.....					12.65	0.54	12.11	4.00
	Average.....							10.00	
A 195*	Potash Formula.....	0.22	0.17	0.36	0.55	12.55	1.60	10.95	
A 2753	Potash Formula.....	0.75	0.12	0.17	0.47	10.65	1.06	9.50	2.01
A 3102	Potash Formula.....	0.01	0.10	0.20	0.40	8.90	1.20	7.40	2.14
A 3336	Potash Formula.....	0.02	0.10	0.20	0.41	8.50	1.30	7.20	2.21
A 3471	Potash Formula.....	0.08	0.17	0.20	0.45	10.65	1.30	9.55	1.59
	Average.....	0.26	0.12	0.23	0.44	9.60	1.01	8.50	1.79
A 2826	Soluble Phosphate and Potash.....							10.00	1.05
A 3475*	Soluble Phosphate and Potash.....					11.25	1.06	10.20	1.06
	Average.....					11.80	0.62	11.18	2.01
	Average.....					11.58	0.84	10.74	2.00

*Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.	Available.	Water Soluble.
A 197* A 2774 A 2774 A 2868 A 3103	Smith Agricultural Chemical Co.—Con. Wheat Maker and Seeding Down..... Wheat Maker and Seeding Down..... Wheat Maker and Seeding Down..... Wheat Maker and Seeding Down.....	{ G.† F.† F.† F.† F.† Average.....	0.16	0.13	0.19	0.41	15.30	1.58	12.00	.....
			0.11	0.11	0.32	0.41	15.10	1.22	13.72	.....
			0.10	0.10	0.28	0.48	14.80	1.56	13.88	.....
			0.09	0.09	0.22	0.40	15.10	1.40	13.24	.....
			0.09	0.11	0.25	0.45	15.08	1.44	13.64	.....
A 3073	The Sodius Humus Co., Benton Harbor, Mich. Sodius Humus.....	{ G.† F.† F.† Benton Harbor.....	0.09	0.32	0.69	1.33 1.10	0.001	.....	.....	0.002
A 3209	The Solvay Process Co., Detroit, Mich. U. S. Potash..... L. Speidel, St. Joseph, Mich.	{ G.† F.† F.† Detroit.....	.....	.....	.....	.....	.....	.....	.....	50.53 55.21
A 3072 A 3169	Fish Tankage..... Fish Tankage..... L. Speidel, St. Joseph, Mich.	{ G.† F.† F.† St. Joseph..... St. Joseph..... Average.....	1.50 1.17	2.76 3.19	3.08 2.82	7.33 7.31 7.18	7.30 9.05	2.32 3.12	4.01 4.98 5.93	.....
A 2829 A 2878 A 3065*	J. L. & H. Stadler Rendering & Fertilizer Co., Cleveland, Ohio. 16% Acid Phosphate..... 16% Acid Phosphate..... 16% Acid Phosphate.....	{ G.† F.† F.† Bad Axe..... Belleville, Mo..... Ida..... Average.....	.....	2.97	2.95	7.26	8.18	2.72	5.46	.....
A 2829 A 2878 A 3065*	16% Acid Phosphate..... 16% Acid Phosphate..... 16% Acid Phosphate.....	{ G.† F.† F.† Bad Axe..... Belleville, Mo..... Ida..... Average.....	.....	.....	.....	.....	17.05 17.95 17.65	0.74 0.78 0.74	16.00 16.31 16.91	.....
A 2776 A 2828 A 2878 A 2927 A 2961 A 3063*	Ammoniated Acid Phosphate..... Ammoniated Acid Phosphate..... Ammoniated Acid Phosphate..... Ammoniated Acid Phosphate..... Ammoniated Acid Phosphate..... Ammoniated Acid Phosphate.....	{ G.† F.† F.† Jasper..... Bad Axe..... Milan..... Mayhew..... Ida..... Average.....	0.43 0.34 0.69 0.47 0.50	0.16 0.19 0.17 0.16 0.17	0.25 0.30 0.21 0.23 0.27	0.80 0.84 0.83 0.86 0.94	12.75 12.50 13.15 12.75 12.10	1.68 1.56 1.76 1.36 1.24	10.86 11.07 10.99 11.39 10.86	.....
		Average.....	0.49	0.17	0.25	0.91	12.65	1.52	11.13	.....

A 3558*	Bone and Acid Phosphate.....	{ G.+ F.+ }	0.69	0.72	0.47	1.40 1.88	18.60 20.58	11.72	8.86	.....
A 3384	General Crop Grower.....	{ G.+ F.+ }	1.04	0.28	0.56	1.60 1.88	12.95	2.20	10.00 10.75	1.00 1.16
	Grain Grower.....	G.+				1.60			10.00	.....
A 2701	Harvest King.....	{ G.+ F.+ }	0.45	0.16	0.25	0.80	11.05	1.22	9.00 9.83	1.00 0.98
A 2762	Harvest King.....	{ G.+ F.+ }	0.37	0.18	0.31	0.86	11.65	1.46	10.19	1.12
A 2783	Harvest King.....	{ G.+ F.+ }	0.43	0.19	0.29	0.91	11.40	1.41	9.96	1.03
A 3602*	Harvest King.....	{ G.+ F.+ }	0.39	0.12	0.28	0.79	11.19	0.94	10.16	1.15
	Average.....	G.+	0.42	0.16	0.28	0.86	11.30	1.27	10.03	1.07
A 3612*	Pure Bone Meal.....	{ G.+ F.+ }	1.24	0.98	0.70	2.80 2.92	20.00 21.65			.....
	Special Bone Meal.....	G.+				1.60	25.00			.....
A 3622*	Valley Phosphate.....	{ G.+ F.+ }	1.36	0.30	0.60	2.65 2.26	11.50	1.68	9.82	1.55
A 2830	Vegetable and Grain Grower.....	{ G.+ F.+ }	0.51	0.18	0.26	0.89	12.75	2.26	10.00 10.49	0.50 0.64
A 2939	Vegetable and Grain Grower.....	{ G.+ F.+ }	0.62	0.16	0.23	1.01	13.60	1.54	12.06	0.59
A 3604*	Vegetable and Grain Grower.....	{ G.+ F.+ }	0.56	0.15	0.23	0.94	13.45	2.00	11.05	0.49
	Average.....	G.+	0.56	0.16	0.24	0.96	13.13	1.93	11.29	0.57
A 2737	Vegetable Manure.....	{ G.+ F.+ }	0.40	0.44	0.33	1.20	14.90	2.12	12.78	.....
A 2940	Vegetable Manure.....	{ G.+ F.+ }	0.74	0.26	0.36	1.36	15.45	2.18	12.87	.....
A 3606*	Vegetable Manure.....	{ G.+ F.+ }	0.64	0.19	0.27	1.10	11.65	1.22	13.43	.....
	Average.....	G.+	0.59	0.30	0.32	1.24	14.87	1.84	13.63	.....
A 1986	Nicholas Swartz, Grand Haven, Mich. Celery Husker.....	{ G.+ F.+ }	1.30	5.91	2.51	7.98 9.72	3.01 4.55	0.66	3.89	.....
	Swift & Company, Chicago, Ill.	G.+				0.82	9.75	1.21	8.51	3.00
A 2884	Bean and Grain Grower 1-8-3.....	{ G.+ F.+ }	0.11	0.19	0.43	0.73	9.75	1.21	8.51	3.11
A 3014	Bean and Grain Grower 1-8-3.....	{ G.+ F.+ }	0.46	0.24	0.21	0.91	10.65	1.20	9.43	2.34
A 3061	Bean and Grain Grower 1-8-3.....	{ G.+ F.+ }	0.56	0.21	0.25	1.00	10.20	1.36	8.84	2.24
A 3500*	Bean and Grain Grower 1-8-3.....	{ G.+ F.+ }	0.56	0.16	0.18	0.90	12.08	2.12	10.86	2.33
A 3608*	Bean and Grain Grower 1-8-3.....	{ G.+ F.+ }	0.46	0.07	0.17	0.70	9.85	0.96	8.89	1.24
	Average.....	G.+	0.43	0.17	0.25	0.85	10.68	1.38	9.30	2.25

Abbreviations for Guaranteed and Found.

*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.	Potash.	
			Total.					
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.			
Swift & Company, Chicago, Ill.—Continued.								
A 2922	Bean and Sugar Beet Grower 1-12-1	Traverse City.....	0.40	0.27	0.28	0.82	12.00	1.00
A 2903	Bean and Sugar Beet Grower 1-12-1	Chelsea.....	0.35	0.23	0.19	0.77	12.20	1.15
A 3082	Bean and Sugar Beet Grower 1-12-1	Jamestown.....	0.49	0.30	0.19	0.88	12.80	1.03
A 3130	Bean and Sugar Beet Grower 1-12-1	Alma.....	0.36	0.20	0.15	0.73	12.42	1.06
	Average.....		0.40	0.23	0.20	0.83	13.76	1.06
A 141*	Champion Wheat and Corn Grower 2-12-2	Albion.....	1.21	0.16	0.18	1.65	12.00	2.00
A 173*	Champion Wheat and Corn Grower 2-12-2	Coldwater.....	1.29	0.19	0.13	1.55	13.58	1.94
A 2854	Champion Wheat and Corn Grower 2-12-2	Elm.....	0.32	0.81	0.47	1.61	14.25	1.72
A 3495*	Champion Wheat and Corn Grower 2-12-2	Zeeland.....	1.09	0.19	0.13	1.60	13.85	1.34
A 3514*	Champion Wheat and Corn Grower 2-12-2	Durion.....	1.19	0.24	0.10	1.41	14.45	1.42
A 3535*	Champion Wheat and Corn Grower 2-12-2	Mulliken.....	1.25	0.13	0.22	1.53	14.10	1.60
	Average.....		1.06	0.29	0.20	1.55	14.37	1.44
A 2681	Clay Soil Special 2-12-0.....	Lansing.....	0.90	0.31	0.45	1.65	12.00	2.06
A 2684	Clay Soil Special 2-12-0.....	Coldwater.....	0.79	0.34	0.42	1.55	13.58	1.56
A 3158	Clay Soil Special 2-12-0.....	Bangor.....	0.79	0.37	0.30	1.46	14.20	1.32
	Average.....		0.83	0.34	0.39	1.56	13.76	1.46
A 150*	Complete Fertilizer 1-8-1.....	Mason.....	0.36	0.10	0.24	0.82	8.00	1.00
A 2600	Complete Fertilizer 1-8-1.....	Davison.....	0.23	0.19	0.20	0.70	9.05	1.23
A 2820	Complete Fertilizer 1-8-1.....	Traverse City.....	0.41	0.23	0.22	0.62	9.93	0.94
A 2856	Complete Fertilizer 1-8-1.....	Elm.....	0.26	0.25	0.26	0.86	9.75	0.87
A 2855	Complete Fertilizer 1-8-1.....	New Boston.....	0.37	0.14	0.24	0.77	11.60	1.01
A 2885	Complete Fertilizer 1-8-1.....	Flat Rock.....	0.57	0.24	0.95	0.95	9.90	1.08
A 2902	Complete Fertilizer 1-8-1.....	Flat Rock.....	0.27	0.30	0.26	0.95	8.23	0.94
A 3553*	Complete Fertilizer 1-8-1.....	Saranac.....	0.51	0.15	0.31	0.83	10.05	0.89
	Average.....		0.37	0.19	0.25	0.97	10.20	0.83
						0.81	9.98	8.58
						0.81	8.52	1.06
A 159*	Diamond K Grain Grower 1-12-1.....	Mason.....	0.64	0.15	0.05	0.82	12.00	1.00
A 2723	Diamond K Grain Grower 1-12-1.....	Reading.....	0.40	0.22	0.21	0.84	12.08	1.13
						0.86	13.95	1.22

A 2900	Diamond K Grain Grower 1-12-1	Flat Rock.....	0.54	0.21	0.18	0.93	13.55	0.84	12.71	0.96
A 2923	Diamond K Grain Grower 1-12-1	North Adams.....	0.63	0.22	0.19	1.04	13.90	1.00	12.90	1.12
A 3496*	Diamond K Grain Grower 1-12-1	Zeeland.....	0.67	0.22	0.06	0.95	14.85	2.06	12.79	0.91
	Average.....		0.58	0.20	0.14	0.92	14.23	1.34	12.89	1.07
A 3321	Diamond S Phosphate 10 ⁶⁰	Fairgrove.....	{ G.†						10.00	
A 3688*	Diamond S Phosphate 10 ⁶⁰	Bad Axe.....	{ F.†				11.60	1.32	10.28	
							12.40	0.92	11.48	
	Average.....						12.00	1.12	10.88	
A 2680	Garden City Phosphate 14 ⁶⁰	Lansing.....	{ G.†				15.93	1.76	14.17	
A 2806	Garden City Phosphate 14 ⁶⁰	Menominee.....	{ F.†				17.40	1.60	15.80	
A 2947	Garden City Phosphate 14 ⁶⁰	Carleton.....					17.60	1.06	16.54	
	Average.....						16.98	1.47	15.51	
A 164*	High Grade Acid Phosphate 16 ⁶⁰	Union City.....	{ G.†						16.00	
A 2686	High Grade Acid Phosphate 16 ⁶⁰	Coldwater.....	{ F.†				18.85	0.44	18.41	
A 2699	High Grade Acid Phosphate 16 ⁶⁰	Quincy.....					17.85	1.42	16.43	
A 2809	High Grade Acid Phosphate 16 ⁶⁰	Menominee.....					18.13	2.24	15.89	
A 3060	High Grade Acid Phosphate 16 ⁶⁰	Niles.....					18.60	1.10	17.50	
	Average.....						18.35	1.36	16.99	
A 3490*	Muck Soil Fertilizer.....	Zeeland.....					18.35	1.31	17.04	
A 3539*	Muck Soil Fertilizer.....	Lake Odessa.....	{ G.†	0.57	0.13	0.82	0.86		12.00	\$ 00
A 3575*	Muck Soil Fertilizer.....	Midleton.....	0.61	0.07	0.18	0.80	14.90	2.22	12.68	1 05
A 3682*	Muck Soil Fertilizer.....	Mt. Morris.....	0.55	0.05	0.12	0.72	15.30	2.06	13.24	2 99
	Average.....		0.70	0.08	0.16	0.94	14.25	1.74	12.51	2 78
							14.85	2.08	12.78	2 76
A 3018	Pulverized Sheep Manure 2-1-1 ¹	Kalamazoo.....	{ G.†	0.61	0.08	0.85	14.83	2.03	12.80	2 29
A 3250	Pulverized Sheep Manure 2-1-1 ¹	Mt. Clemons.....	{ F.†	0.25	0.50	1.05	1.00			1 50
A 3314	Pulverized Sheep Manure 2-1-1 ¹	Flint.....	0.38	0.81	1.07	2.26	3.20	0.88	2.32	2 25
	Average.....		0.19	0.52	1.14	1.85	2.00	0.48	0.97	2 49
							2.11	0.51	1.52	2 23
A 2685	Special Superphosphate 2-8-1.....	Coldwater.....	{ G.†	0.27	0.61	1.14	2.02		1.69	2 32
A 2808	Special Superphosphate 2-8-1.....	Menominee.....	{ F.†	0.34	0.60	0.55	1.65		8.00	1 00
A 2821	Special Superphosphate 2-8-1.....	Traverse City.....	0.46	0.72	0.80	1.66	10.13	2.70	7.43	1 00
	Average.....		0.31	0.69	0.64	1.78	10.28	3.35	6.93	1 15
							10.72	3.10	7.62	1 17

Abbreviations for Guaranteed and Found.
*Fall Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.				Phosphoric Acid.			Potash.
			As Soluble	As Active Insoluble Organic	As Inactive Insoluble Organic	Total.	Total.	Insoluble.	Available.	
		(G. + F.)								
A 3157 A 3570* A 3658*	Swift & Company, Chicago, Ill.—Con. Superphosphate 2-8-2 Superphosphate 2-8-2 Superphosphate 2-8-2	Ransom.....	0.26	0.61	0.46	1.65	10.13	2.51	8.00	2.00
		Elise.....	0.41	0.72	0.44	1.33	10.70	2.80	7.62	1.58
		Shafsbury.....	1.11	0.15	0.15	1.39	9.30	1.26	8.04	1.83
		Average.....	0.59	0.51	0.35	1.45	10.04	2.19	7.85	1.79
A 172* A 2683 A 2700 A 2815 A 2855 A 2901 A 3062	Tankage and Bone Phosphate 1-12-0 Tankage and Bone Phosphate 1-12-0 Tankage and Bone Phosphate 1-12-0 Tankage and Bone Phosphate 1-12-0 Tankage and Bone Phosphate 1-12-0 Tankage and Bone Phosphate 1-12-0 Tankage and Bone Phosphate 1-12-0	(G. + F.)								
		Collwater.....	0.50	0.21	0.07	0.82	14.95	1.52	13.43	12.00
		Collwater.....	0.30	0.35	0.25	0.90	14.33	1.52	12.81	13.43
		Quincy.....	0.33	0.25	0.26	0.84	14.05	1.00	13.05	12.81
		Boyan City.....	0.35	0.22	0.22	0.84	14.50	1.10	13.40	13.40
		Boyan.....	0.38	0.27	0.19	0.84	14.60	1.22	13.38	13.38
		Flat Rock.....	0.46	0.26	0.15	0.87	13.50	1.04	12.46	12.46
		Flat Rock.....	0.37	0.19	0.23	0.79	13.20	1.02	12.18	12.18
		Niles.....	0.41	0.26	0.19	0.85	14.16	1.20	12.96	12.96
		Average.....	0.40	0.26	0.19	0.85	14.16	1.20	12.96	12.96
A 2082 A 2807 A 3013 A 3053	Trunk Fertilizer 3-8-1 Trunk Fertilizer 3-8-1 Trunk Fertilizer 3-8-1 Trunk Fertilizer 3-8-1	(G. + F.)								
		Lansing.....	0.49	1.04	0.76	2.45	10.55	3.55	8.00	1.00
		Memphis.....	0.56	0.87	0.66	2.49	10.63	4.11	7.00	1.05
		Kalamazoo.....	1.87	0.40	0.06	2.49	10.30	3.08	6.49	1.18
A 2769 A 3312 A 3355	Wheat and Rye Special 2-10-0 Wheat and Rye Special 2-10-0 Wheat and Rye Special 2-10-0	Decatur.....	0.97	0.82	0.74	2.51	10.20	2.94	7.22	1.27
		Average.....	0.96	0.80	0.56	2.32	10.42	3.43	6.99	1.14
		Adrian.....	0.66	0.39	0.48	1.65	12.45	2.60	10.00	10.00
		Zeeland.....	0.60	0.47	0.23	1.42	13.20	2.81	9.85	9.85
A 3407* A 3676*	1-8-2 Fertilizer 1-8-2 Fertilizer 1-8-2 Fertilizer 1-8-2 Fertilizer	Union City.....	0.77	0.43	0.47	1.67	12.45	1.54	10.86	10.86
		Average.....	0.68	0.43	0.38	1.49	12.70	2.16	10.54	10.54
		Zeeland.....	0.20	0.27	0.29	0.82	9.68	1.03	8.00	2.00
		Ann Arbor.....	0.53	0.05	0.10	0.68	9.05	0.94	7.75	1.91
A 3407* A 3676*	1-8-2 Fertilizer 1-8-2 Fertilizer	Average.....	0.37	0.16	0.19	0.72	9.36	1.43	7.93	2.20

A 2982 A 3076	V-C Prolific Grain Grower. V-C Prolific Grain Grower.	Lenawee Junction. Jenison.						13.15 12.35	0.78 0.74	12.37 11.61	2.02 2.11
	Average.							12.55	0.79	11.76	2.05
A 2766 A 3216	V-C Red Cross 14% V-C Red Cross 14%.	Erie. Milan.	{G.† {F.†					20.05 19.60	4.12 2.68	14.00 16.92	
	Average.							19.83	3.40	16.43	
A 2944	V-C Rescue Fertilizer.	Urania.	{G.† {F.†	1.11	0.37			1.65 1.78		11.00 12.82	
A 2984	V-C Richumus Fertilizer.	Lenawee Junction.	{G.† {F.†	0.04	0.19	0.30		0.41 0.53	1.56	12.00 13.04	
A 3447*	V-C Springfall Fertilizer.	Coopersville.	{G.† {F.†	1.39	0.15	0.09		1.65 1.63	0.62	12.00 13.03	2.00 2.79
A 2972	V-C Sure Grain Producer.	Manchester.	{G.† {F.†	0.27	0.22	0.34		0.82 0.83	0.44	13.00 15.31	
Basin Monumental Brands.											
A 2963 A 2767 A 3003	16% Acid Phosphate. 16% Acid Phosphate. 16% Acid Phosphate.	Batavia. Adrian. Eau Claire.	{G.† {F.† {F.†					19.63 18.75 18.90 19.55	0.88 0.98 1.08 0.60	16.00 18.75 17.82 18.45	
	Average.							19.36	0.85	18.51	
A 2766	20% Acid Phosphate.	Adrian.	{G.† {F.†					23.60	0.74	20.00 22.86	
A 2678 A 2665	Farmers Success. Farmers Success.	Lansing. Batavia.	{G.† {F.†	0.26 0.12	0.30 0.39	0.35 0.44		0.82 0.91 0.95	0.98 1.28	8.00 8.47 8.65	1.00 1.70 1.43
	Average.			0.19	0.35	0.39		0.93	1.13	8.25	1.37
A 2692	General Favorite.	Batavia.	{G.† {F.†	0.74	0.91	0.61		1.65 2.25		8.00 7.40	2.00 1.98
A 2677	Grain Fertilizer.	Lansing.	{G.† {F.†	0.55	0.31	0.24		0.82 1.08	0.90	12.00 13.85	
A 2679	Reliable Wheat and Corn Fertilizer.	Lansing.	{G.† {F.†	0.28	0.29	0.50		0.89 1.07	1.50	8.00 8.82	2.00 2.02
A 2771	Special Plant Food.	Adrian.	{G.† {F.†	1.06	0.36	0.24		1.65 1.66	0.92	11.00 12.48	

†Abbreviations for Guaranteed and Found.

*Full Samples.

ANALYSES OF COMMERCIAL FERTILIZER FOR 1919, EXPRESSED IN PARTS IN ONE HUNDRED.—CONTINUED.

Laboratory No.	Manufacturer and Trade Name.	Sampled at	Nitrogen.			Phosphoric Acid.			Potash.
			As Soluble.	As Active Insoluble Organic.	As Inactive Insoluble Organic.	Total.	Total.	Insoluble.		Available.
Wayne Soap Company, Detroit, Mich.									
A 3256	Fertilo Brand Fertilizer.....	{ G. † { F. †	0.98	1.12	0.86	2.96	17.20	13.23	8.00 3.97
	Garden Brand Fertilizer.....	G. †				2.30			6.00 5.00
A 3315	Blood and Bone.....	{ G. † { F. †	1.52	1.46	0.84	3.82	24.20	16.68	8.00 7.52
A 3395	Wuichet Fertilizer Company, Dayton, Ohio. 14% Acid Phosphate.....	{ G. † { F. †					17.30	0.34	14.00 16.96
A 3575*	16% Phosphate.....	{ G. † { F. †					18.25	1.10	16.00 17.15
	EE Ammonia Special.....	G. †				0.80			10.00
	EE Raw Bone & Phosphate.....	G. †				1.00			8.00
A 146*	EE Ruby Phosphate.....	{ G. † { F. †	0.20	0.10	0.08	0.40	14.80	1.08	11.00
A 2658	EE Ruby Phosphate.....	Davidson.....	0.15	0.21	0.13	0.49	12.60	1.56	13.72
A 2743	EE Ruby Phosphate.....	Owosso.....	0.11	0.21	0.16	0.48	12.90	0.98	11.92
A 3121	EE Ruby Phosphate.....	Muir.....	0.19	0.11	0.11	0.41	12.35	1.14	11.21
A 3126	EE Ruby Phosphate.....	Carson City.....	0.14	0.19	0.09	0.42	13.15	1.48	11.67
A 3569*	EE Ruby Phosphate.....	Ovid.....	0.13	0.21	0.11	0.45	11.00	2.04	8.96
	Average.....		0.15	0.18	0.11	0.44	12.80	1.38	11.42
A 125*	EE Spot Cash.....	{ G. † { F. †	0.12	0.21	0.37	0.80	10.70	2.97	8.00 7.73
A 147*	EE Spot Cash.....	Mason.....	0.15	0.14	0.30	0.59	11.55	2.24	9.31 1.06
A 2744	EE Spot Cash.....	Owosso.....	0.35	0.23	0.33	0.91	8.58	1.82	6.76 0.74
A 2745	EE Spot Cash.....	Perry.....	0.27	0.26	0.26	0.79	13.40	2.82	10.58
A 3120	EE Spot Cash.....	Muir.....	0.23	0.15	0.31	0.69	9.70	1.76	7.94 0.94
	Average.....		0.22	0.20	0.31	0.73	10.79	2.32	8.47 1.15

*Abbreviations for Guaranteed and Found.

*Fall Samples.

DIRECTIONS FOR MAKING A GOOD FLAVORED CIDER VINEGAR.

Special Bulletin No. 93

1. Use varieties of apples (see page 504, also tables II and III) the cider from which will read at least ten per cent. sugar on the saccharimeter scale (see pages 500 to 502, also table I, p. 505).
2. Observe cleanliness throughout the whole cider and vinegar-making process. Use clean sound fruit (see page 505). Use a clean cider press, catch and store the juice in thoroughly cleansed containers (see page 506).
3. Fill the cider barrel so as to furnish optimum air conditions (see page 506) for the growth of the yeast which is first concerned in the vinegar fermentation, (see page 499).
4. The first stage of the vinegar fermentation will now start (see page 499) but it can be more readily controlled if a pure culture of a selected yeast is added as a starter (see pages 495 and 512).
5. The temperature at which the barrel is placed should also be favorable to the growth of the yeast (see pages 506 and 507).
6. When the alcoholic fermentation is over (see page 499) as will be noted by the cessation of gas formation and a drop in the percentage of sugar (see pages 499 and 500), rack or siphon off the "hard" cider from the dregs (see page 508) into a clean barrel.
7. Prepare the barrel, observing ideal conditions as nearly as possible (as illustrated in Fig. 5, page 507) and either add good strong cider vinegar containing "mother" (see page 513) or *preferably*, inoculate with a pure culture of vinegar bacteria (see pages 512 and 513).
8. Observe the *air* (see pages 499, 506, and Fig. 495) and also the *temperature* requirements (see pages 506 to 511) for the optimum development of the vinegar bacteria.
9. Be careful not to disturb the film of acetic bacteria forming on the surface of the alcoholic liquid or the result may be disastrous to the further formation of the vinegar acid (page 511).
10. When sufficient acid has formed (see page 497 for Michigan standard and page 508 for time necessary) vinegar should be so treated and stored (see pages 508 and 509) that the acid cannot be destroyed by undesirable micro-organisms (pages 511-512) or by the vinegar bacteria themselves (page 511).
11. Vinegar may be made from other substances with success (pages 497, 498, to 518).

APPLICATION FOR PURE CULTURES OF VINEGAR YEAST
AND BACTERIA.

SHOW THIS TO A NEIGHBOR.

Date.....

Name

Post Office..... County.....

State..... R. F. D.....

I desire to cooperate with the Bacteriological Laboratory of the Michigan Agricultural College in its attempt to produce a better vinegar and to overcome losses by off-fermentations.

- I will endeavor to, 1. carry out instructions carefully,
2. observe all changes accurately and,
3. report these changes and results

as soon as the fermentation is completed by filling out the "Report Blank" sent with the cultures and returning it to the Bacteriological Laboratory.

Probable date of using cultures.....19....

(Yeast cultures should be ordered one to two weeks before fruit juice is expressed; cultures of vinegar bacteria should be ordered as soon as the alcoholic fermentation is over.)

I wish.....yeast cultures to control the alcoholic fermentation, the first stage of vinegar production, and.....cultures of vinegar bacteria to control the acetic acid fermentation, the second and last stage of vinegar production.

One culture each of yeast and vinegar bacteria is sufficient for a barrel two-thirds full of freshly expressed fruit juice. If the alcoholic fermentation is over (as evidenced by the cessation of foaming) a pure culture of vinegar bacteria alone will be sufficient.

A nominal charge of 25 cents per culture is made to cover cost of material and shipping. No amount less than a single culture will be sent. Two or more cultures will be forwarded at 25 cents each.

Enclosed find \$..... Send money preferably by money order. No stamps accepted.

Address this application when filled out in a sealed envelope to the

BACTERIOLOGICAL LABORATORY,
MICHIGAN AGRICULTURAL COLLEGE,
East Lansing, Michigan.

VINEGAR.

ZAE NORTHRUP WYANT.

Definition: Vinegar is a condiment produced by the successive alcoholic and acetic fermentation of a watery solution of sugary or starchy substances by certain yeasts and bacteria.

The Michigan Dairy and Food Laws (1917) define vinegar as follows: (Act No. 384, Session Laws 1913), paragraph 67, section 2: "The word 'vinegar' as used herein is limited to a water solution of acetic acid derived by the alcoholic and subsequent acetous fermentations of fruits, grain, vegetables, sugar or syrups, and if not distilled must carry in solution the extractive matter derived solely from the substances indicated on the label as its source."

Raw Materials: Vinegar may be made from practically all fruits, as apples, pears, peaches, apricots, plums, prunes, grapes, cherries, currants, berries of most all kinds, oranges, pineapples, etc.; from grains, such as barley, rye, wheat, corn, in fact any cereal whose starch may be converted to malt sugar; from vegetables, such as sugar beets and tomatoes; from cane, beet, maple, etc., sugar and syrups, molasses, and honey; and from sweet whey. On the farm, many of the above products that would otherwise go to waste may be utilized in this way.

Vinegar from most of the above-mentioned raw materials is recognized and defined by state law. These sections of the law are given here as many fruit or grain growers, maple syrup makers, bee-keepers, and the like may have a large excess of raw material, or a quantity of waste that can be utilized in no other way, and they should be familiar with the requirements of the law if they wish to sell their product.

Cider vinegar: Paragraph 68, Section 3 of Act No. 384: "No vinegar shall be sold or exposed for sale as apple or cider vinegar which is not the legitimate product of pure apple juice. The term 'cider vinegar' as used herein shall be construed to mean vinegar derived by the alcoholic and subsequent acetous fermentation of the expressed juice of apples, the acidity, solids and ash of which have been derived exclusively from apples, and which contains not less than four per cent of absolute acetic acid. Cider vinegar which during the course of manufacture has developed in excess of four per cent acetic acid, may be reduced to a strength of not less than four per cent, and cider vinegar so reduced shall not be regarded as adulterated. Every manufacturer or producer of cider vinegar shall plainly brand on the head of the cask, barrel or keg or other container of such vinegar, his name, place of business and the words 'fermented cider vinegar,' and no person shall mark or brand as cider vinegar any package containing that which is not cider vinegar. Any vinegar sold or offered for sale shall be marked or branded plainly

upon the package or container from which it is sold and also on the original package or container in which it is sold or delivered, in a manner to show its true character and source."

Sugar vinegar: Paragraph 69, Section 4 of Act No. 384: "All sugar vinegar sold or exposed for sale as such shall be strictly and distinctly fermented from sucrose, molasses or refiner's syrup."

Malt vinegar: Paragraph 70, Section 5 of Act No. 384: "No vinegar shall be sold or exposed for sale as malt vinegar which is not fermented strictly and distinctly from barley malt, or cereals whose starch has been converted to malt."

The rest of the state law which is pertinent follows:

Par. 71, Sec. 6: No vinegar shall be sold or exposed for sale in which foreign substances, drugs or acids shall have been introduced. No vinegar shall contain any artificial coloring matter, and all vinegar shall have an acidity of not less than four per cent by weight of absolute acetic acid. If vinegar contains any artificial matter, or less than the required amount of acidity, it shall be deemed to be adulterated."

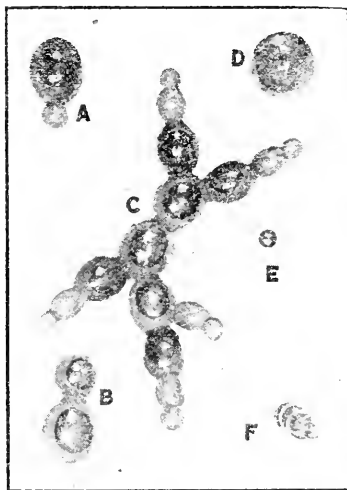


Fig. 1. Photograph of a model of a yeast showing its development during fermentation: A, new yeast cell just budding; B, bud has enlarged nearly to size of parent cell; C, colony formed by budding yeast cells; D, old yeast cell has become spherical and spores have formed within. The cell is now called an ascus; E, liberated spores, the center one beginning to germinate; F, the cell formed from the germinating spore has budded and rebudded and another colony will soon be formed. In the active alcoholic fermentation the yeasts will be found in stages A, B and C only.

Par. 72, Sec. 7: "All vinegar made by fermentation and oxidation without the intervention of distillation, shall be branded 'fermented' vinegar, with the name of the fruit or substance from which such vinegar has been made."

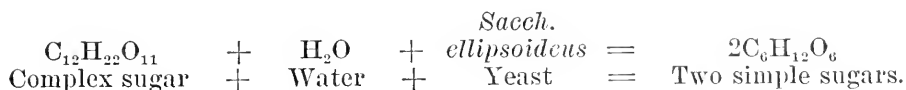
Par. 73, Sec. 8: "All vinegar made by acetous fermentation of dilute distilled alcohol shall be branded 'distilled' vinegar, together with the name of the substance or substances from which it is made, and all vinegar made wholly or in part from distilled vinegar shall be conspicuously labeled 'distilled vinegar.'"

Par. 74, Sec. 9: "Whoever violates any of the provisions of this act

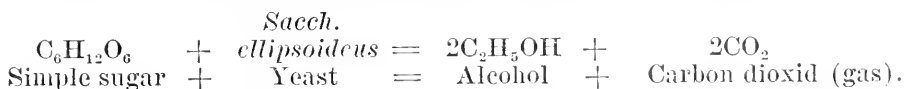
shall, upon conviction, be punished by a fine of not more than two hundred dollars or imprisonment in the county jail not to exceed six months or both such fine and imprisonment in the discretion of the court."

THE VINEGAR FERMENTATION.

The vinegar fermentation is in reality two distinct fermentations, one following the other. The first, the formation of alcohol from sugar is accomplished by alcohol-producing yeasts of which *Saccharomyces ellipsoides* is the best example. These yeasts change the sugar into alcohol according to the following chemical equations:



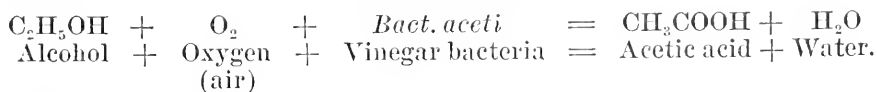
Then the simple sugars are changed into alcohol as follows:



The sugars in most fruits and in honey are largely simple sugars, while the sugars derived from grains, cane sugar, syrups and molasses, from sugar beets, and from maple syrups, consist largely of complex sugars.

Besides sugar, of which the solids in cider largely consist, the chemicals represented by the acidity and ash just mentioned in the state law, are quite necessary for the yeast to carry on the alcoholic fermentation as also they are for the subsequent acetic fermentation. The acidity of cider is due mainly to malic acid, which serves to check the development of putrefactive bacteria. The ash, consisting largely of potassium salts and salts of other minerals, furnishes the mineral elements which are as necessary to microbial as to human foods. For the best results this first stage, i. e., the alcoholic fermentation should be kept rigidly separate from the next stage in vinegar formation, the acetic fermentation.

The second fermentation in vinegar production, the formation of acetic acid from alcohol, is accomplished by the vinegar bacteria, of which *Bacterium aceti* is the most prominent type. These vinegar bacteria of which the "mother of vinegar" consists largely, need the oxygen of the air in order to change the alcohol into acetic acid, as is shown by the following chemical equations:



Yield of Vinegar: In these fermentations 100 parts of sugar in the juice should produce theoretically about 51 parts of alcohol; that is, about half as much alcohol by weight should be obtained as there was sugar in the juice. In actual practice only from 45 to 47 per cent is obtained because some of the sugar is used by *Sacch. ellipsoides* and other microorganisms for purposes other than alcohol production.

In the conversion of alcohol into acetic acid 100 parts of alcohol should yield theoretically 130 parts of acetic acid, but less than 120 parts are actually obtained because certain other yeasts and bacteria, which are quite sure to be present, also use alcohol as food.

Thus for every 100 parts of sugar present in the original sugary solution under favorable conditions, 50 to 55 parts of acetic acid should be obtained. So if a vinegar containing 5 per cent acetic acid is desired, the fermentation should be started with at least a 10 per cent sugar solution, while for a 4 per cent acetic acid content (Michigan standard) the sugar solution (fruit juice, etc.) must contain at least 8 per cent sugar. (See Table I.)

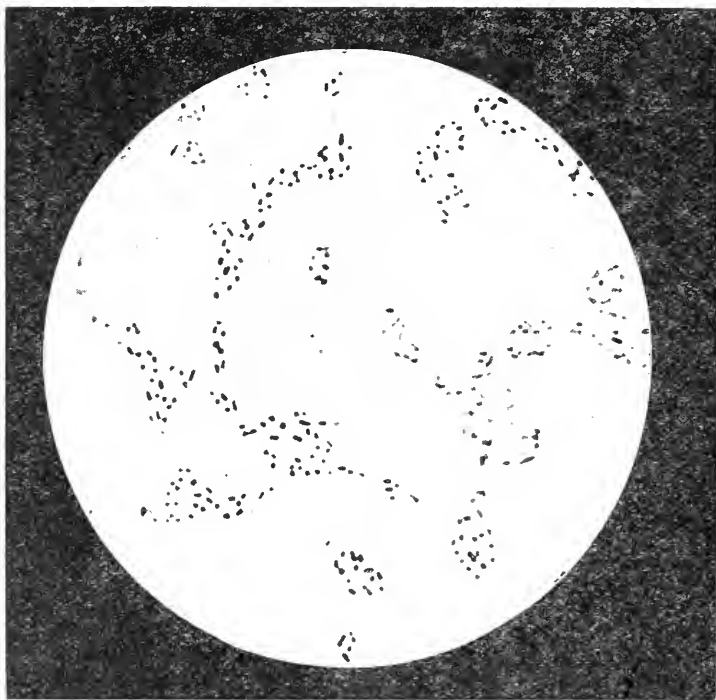


Fig. 2. Photograph of Vinegar Bacteria. Magnified 2,000 times. These bacteria secrete a gelatinous material which binds them together and produces the membrane known as "mother of vinegar."

IMPORTANT POINTS IN VINEGAR MAKING.

Use of a saccharimeter: In order to *know* that the sugar in the freshly pressed fruit juice, freshly diluted sugar, syrup, molasses, honey, etc., is of sufficiently high percentage to make ultimately vinegar of market standard, it is necessary that a saccharimeter or hydrometer for sugar be used. This is merely a hydrometer, reading directly in percentages of sugar, and is indispensable if you wish to start your vinegar right.

Brix or Balling's hydrometers read directly in percentages of sugar but Beaumé's hydrometer scale readings are somewhat different so if

it is possible to obtain only the latter type of hydrometer, Table I may be consulted for obtaining the actual percentage of sugar. For cider a Brix hydrometer reading from 0° to 30° is desirable. A medium grade Brix hydrometer for sugar costing seventy-five cents is listed as No. 7774 in the catalog of the Central Scientific Co., Chicago, Illinois. A hydrometer jar for use with the hydrometer is No. 3650E at fifty cents. As the hydrometer readings are not accurate unless read at the tempera-

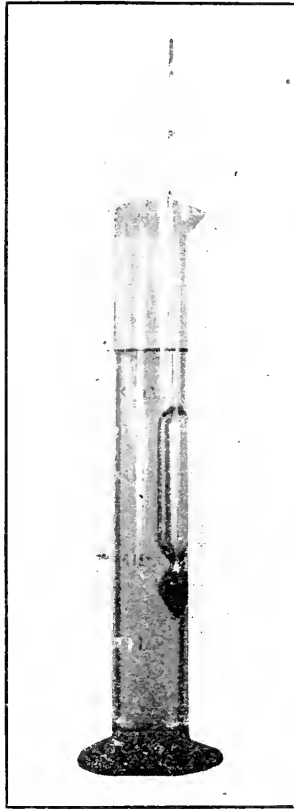


Fig. 3. How to use the Brix Saccharimeter or Hydrometer for Sugar. The hydrometer reading is about 13.5° Brix or 13.5 per cent. cane sugar. The saccharimeter should not touch the side of the cylinder when read.

ture for which they are graduated, a reliable thermometer is indispensable. No. 13430 thermometer having both the Centigrade and Fahrenheit scales, listed at \$1.80 will be very useful in other capacities. The cider to be tested for its sugar content must be cooled down or warmed up to the degree Centigrade or Fahrenheit for which the saccharimeter is regulated. This temperature will be stated on the hydrometer.

Directions for using a saccharimeter or hydrometer for sugar: After regulating the temperature of the cider or other fruit juice, place it in a tall narrow glass cylinder as shown in Fig. 3, and carefully lower the spindle into the solution so that the surface of the stem above the

liquid is not moistened. The hydrometer should float freely and not touch the bottom or walls of the cylinder. To read the hydrometer, bring the eye on a level with the surface of the solution and note where the true surface of the liquid intersects the scale; disregard the film of liquid drawn up around the stem by capillarity. For example, the true reading on the hydrometer in Fig. 4 is 20 and not 17.

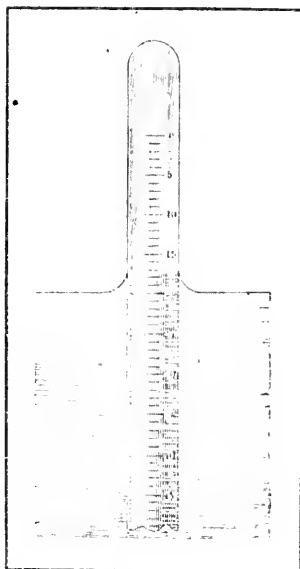


Fig. 4. Method of Reading the Saccharimeter. The reading should be taken at the bottom of the meniscus. The above reading shows 20 per cent. cane sugar. See directions for use, page 501.

TABLE I

COMPARATIVE READINGS ON THE BRIX (OR BALLING*) AND BAUME SACCHARIMETERS, WITH THE APPROXIMATE PERCENTAGES OF ALCOHOL AND ACETIC ACID WHICH MAY BE OBTAINED THEORETICALLY IN THE VINEGAR FERMENTATION.

Per cent cane sugar by wt. or degrees Brix or Balling.	Degrees Baumé.	Theoretical percentage of		Per cent cane sugar by wt. or degrees Brix or Balling.	Degrees Baumé.	Theoretical percentage of		Per cent cane sugar by wt. or degrees Brix or Balling.	Degrees Baumé.	Theoretical percentage of	
		Alcohol.	Acetic acid.			Alcohol.	Acetic acid.			Alcohol.	Acetic acid.
0.0	0.0	0.00	0.00	5.0	2.8	2.69	3.50	10.0	5.7	5.38	7.00
0.1	0.1	.....	.....	5.1	2.9	.....	.....	10.1	5.7	.....	.....
0.2	0.1	.....	.....	5.2	2.95	.....	.....	10.2	5.8	.....	.....
0.3	0.2	.....	.....	5.3	3.0	.....	.....	10.3	5.8	.....	.....
0.4	0.2	.....	.....	5.4	3.1	.....	.....	10.4	5.9	.....	.....
0.5	0.3	2.27	0.35	5.5	3.1	2.96	3.85	10.5	5.9	5.65	7.35
0.6	0.3	.....	.....	5.6	3.2	.....	.....	10.6	6.0	.....	.....
0.7	0.4	.....	.....	5.7	3.2	.....	.....	10.7	6.1	.....	.....
0.8	0.45	.....	.....	5.8	3.3	.....	.....	10.8	6.1	.....	.....
0.9	0.5	.....	.....	5.9	3.35	.....	.....	10.9	6.2	.....	.....
1.0	0.6	0.54	0.70	6.0	3.4	3.23	4.20	11.0	6.2	5.92	7.70
1.1	0.6	.....	.....	6.1	3.5	.....	.....	11.1	6.3	.....	.....
1.2	0.7	.....	.....	6.2	3.5	.....	.....	11.2	6.3	.....	.....
1.3	0.7	.....	.....	6.3	3.6	.....	.....	11.3	6.4	.....	.....
1.4	0.8	.....	.....	6.4	3.6	.....	.....	11.4	6.5	.....	.....
1.5	0.85	0.81	1.05	6.5	3.7	3.50	4.55	11.5	6.5	6.19	8.05
1.6	0.9	.....	.....	6.6	3.7	.....	.....	11.6	6.6	.....	.....
1.7	1.0	.....	.....	6.7	3.8	.....	.....	11.7	6.6	.....	.....
1.8	1.0	.....	.....	6.8	3.9	.....	.....	11.8	6.7	.....	.....
1.9	1.1	.....	.....	6.9	3.9	.....	.....	11.9	6.7	.....	.....
2.0	1.1	1.08	1.40	7.0	4.0	3.77	4.90	12.0	6.8	6.46	8.40
2.1	1.2	.....	.....	7.1	4.0	.....	.....	12.1	6.8	.....	.....
2.2	1.2	.....	.....	7.2	4.1	.....	.....	12.2	6.9	.....	.....
2.3	1.3	.....	.....	7.3	4.1	.....	.....	12.3	7.0	.....	.....
2.4	1.4	.....	.....	7.4	4.2	.....	.....	12.4	7.0	.....	.....
2.5	1.4	1.35	1.75	7.5	4.25	4.04	5.25	12.5	7.1	6.83	8.75
2.6	1.5	.....	.....	7.6	4.3	.....	.....	12.6	7.1	.....	.....
2.7	1.5	.....	.....	7.7	4.4	.....	.....	12.7	7.2	.....	.....
2.8	1.6	.....	.....	7.8	4.4	.....	.....	12.8	7.2	.....	.....
2.9	1.6	.....	.....	7.9	4.5	.....	.....	12.9	7.3	.....	.....
3.0	1.7	1.62	2.10	8.0	4.5	4.31	5.60	13.0	7.4	7.10	9.10
3.1	1.8	.....	.....	8.1	4.6	.....	.....	13.1	7.4	.....	.....
3.2	1.8	.....	.....	8.2	4.6	.....	.....	13.2	7.5	.....	.....
3.3	1.9	.....	.....	8.3	4.7	.....	.....	13.3	7.5	.....	.....
3.4	1.9	.....	.....	8.4	4.8	.....	.....	13.4	7.6	.....	.....
3.5	2.0	1.88	2.45	8.5	4.8	4.58	5.95	13.5	7.6	7.37	9.45
3.6	2.0	.....	.....	8.6	4.9	.....	.....	13.6	7.7	.....	.....
3.7	2.1	.....	.....	8.7	4.9	.....	.....	13.7	7.75	.....	.....
3.8	2.2	.....	.....	8.8	5.0	.....	.....	13.8	7.8	.....	.....
3.9	2.2	.....	.....	8.9	5.0	.....	.....	13.9	7.9	.....	.....
4.0	2.3	2.15	2.80	9.0	5.1	4.85	6.30	14.0	7.9	7.64	9.80
4.1	2.3	.....	.....	9.1	5.2	.....	.....	14.1	8.0	.....	.....
4.2	2.4	.....	.....	9.2	5.2	.....	.....	14.2	8.0	.....	.....
4.3	2.4	.....	.....	9.3	5.3	.....	.....	14.3	8.1	.....	.....
4.4	2.5	.....	.....	9.4	5.3	.....	.....	14.4	8.1	.....	.....
4.5	2.55	2.42	3.15	9.5	5.4	5.11	5.65	14.5	8.2	7.91	10.15
4.6	2.6	.....	.....	9.6	5.4	.....	.....	14.6	8.3	.....	.....
4.7	2.7	.....	.....	9.7	5.5	.....	.....	14.7	8.3	.....	.....
4.8	2.7	.....	.....	9.8	5.55	.....	.....	14.8	8.4	.....	.....
4.9	2.8	.....	.....	9.9	5.6	.....	.....	14.9	8.4	.....	.....
5.0	2.8	2.69	3.50	10.0	5.7	5.38	7.00	15.0	8.5	8.18	10.50

*The Brix and Balling saccharimeters both read directly in percentages of cane sugar. They may differ, however, in the temperature at which they are to be read.

Adapted from Table 3, Appendix, of C. A. Browne's Handbook of Sugar Analysis (1912).

Variations in sugar content of apples: The juice of ripe apples has been found to vary in sugar content from 7 to 15 per cent., the average for a large number of varieties in different states being nearly 11 per cent. Summer apples have been found to average the lowest in sugar content, winter apples highest and fall apples intermediate.

TABLE II
SUGAR CONTENT OF GROWING APPLES.*
Sweet vs. Other Apples.

Date.	Total sugar as invert.		Date.	Total sugar as invert.	
	Summer Apples.			Winter Apples.	
	Yellow Trans- parent.	Bough. (sweet)		Winter Paradise. (sweet)	Ben Davis.
June 11	4.10	5.64	June 16	4.45	3.87
June 17	5.91	6.04	June 30	4.23	3.74
June 25	6.58	7.17	July 28	6.34	5.71
July 2	6.67	7.02	Aug. 18	6.68	5.90
July 7	8.00	7.69	Sept. 24	7.47	7.56
July 15	8.15	8.77	Oct. 15	8.84	8.60
July 17	9.02	9.23	Oct. 23	9.63	9.60
July 22	8.78	6.93	Oct. 30	9.87	9.91
July 24	9.21	9.54	Nov. 5	9.36	9.74
July 29	8.89	8.78			

TABLE III
MALIC ACID CONTENT OF APPLES.*
Sweet vs. Other Apples.

Date.	Summer Apples.			Date.	Winter Apples.		
	Bough. (sweet)	Early Strawberry.	Yellow Trans-parent.		Winter Paradise. (sweet)	Huntsman.	Ben Davis.
June 11.....	0.295	1.38	1.77	June 16.....	0.38	1.43	1.64
July 10.....	0.211	1.62	0.81	July 28.....	0.12	0.80	0.89
July 29.....	0.164	0.70	0.79	Sept. 24.....	0.09	0.37	0.52

*Tables II and III taken in part from Table VI, "Studies on Apples," Bul. 94, Bur. of Chem., U. S. D. A. (1905) pp. 45, 46, by W. D. Bigelow, H. C. Gore and B. J. Howard.

Mature ripe apples contain the largest amount of sugar; green apples contain a much smaller quantity, and over-ripe apples contain less sugar than ripe apples (see Table II). Contrary to the usual belief, sweet apples are ordinarily no richer in sugar than sour apples. They taste sweet because they contain less malic acid than sour apples (see Table III). (Malic acid is the acid normally found in apples.) Thus it is readily seen that the practice some amateur vinegar makers have of adding well or rain-water to their cider is a very poor one as the percentage of sugar in apple juice is rarely too high.

Certain varieties of apples which make an excellent cider to drink do not make good vinegar because of the relatively small amount of sugar present.

When dilution is necessary: As a rule, however, it will be necessary to add water to sugars, syrups, molasses and honey to lessen the percentage of sugars present so that the desired micro-organisms can grow. Here again a saccharimeter is indispensable. The large percentage of sugar which exists in the above substances as found on the market acts as an antiseptic toward any germ growth.

Necessity of mineral salts for the vinegar fermentation: Any fruit juice or sugary solution in which active alcoholic fermentation sets in spontaneously and rapidly nears completion, generally contains sufficient quantities of the necessary mineral salts. Some sugary solutions, however, such as certain diluted syrups and honey lack certain elements, i. e., phosphorus and nitrogen, necessary for the rapid growth of the vinegar organisms. These necessary elements can be furnished by the addition of certain phosphates and ammonium salts. The proportions will be given later (p. 517).

Selection of raw materials: In the fruit growing sections of the state thousands of bushels of apples and other fruits are allowed to go to waste annually just because it is too much trouble to gather them and make some use of them. This is particularly true during a season when prices are low owing to overproduction. Such a practice would be condemned by any commercial firm as a most extravagant waste, showing a lack of scientific management. Much of this second-grade fruit has great latent possibilities. It may be expressed and made into fruit juice, or fruit butter, jelly, or vinegar may be made. If the fruit grower could realize that a large percentage of his profits would come from the complete utilization of his second-grade fruit, there would be practically nothing wasted. This same principle applies also to the bee-keeper and the maple syrup maker.

"Second-grade fruit" must not be interpreted to mean rotten, wormy, dirty or unripe fruit. The flavor of the expressed juice or vinegar made from spoiled or unripe fruit can not be "camouflaged," and what is more, it is practically out of the question to control the fermentation, because of the large quantities of undesirable organisms associated with such a poor quality of fruit. The fruit should be first thoroughly washed in clean water. Besides removing the dirt, this process rids the fruit of a large number of undesirable germs. Fruit which has been merely bruised can be used, and where it is not too badly rotted, the spoiled portion can be cut out.

Similarly unmarketable honey, i. e., that from brood combs, from hives infected with foul-brood, honey-dew honey, coniferous honey, washings from the extractor, etc., can be utilized to good advantage in vinegar making. It is desirable in utilizing honey extracted from combs taken from foul-brood infected hives, to boil the diluted honey in order to destroy the germs of the infectious bee disease. These germs are not known to be harmful to man.

Also maple syrup, if of unmarketable grade, i. e., of strong flavor, very dark, or slightly scorched may be made into very acceptable vinegar, for home use at least.

Containers and their preparation: The containers most satisfactory for fruit juices and other sugary solutions to be made into vinegar are barrels that have been tightly bunged or newly emptied ones which have contained whiskey or brandy, or those that have been used for grain alcohol. Molasses barrels and old vinegar barrels should not be used until they have been very carefully and thoroughly cleaned and *scalded*; this applies even to new barrels. The reason that the first-named type of barrels is preferable is that whiskey and brandy being distilled drinks are high in alcohol and this acts as an antiseptic toward most microbes present. At this particular period in Michigan's history the vinegar maker should have little trouble in obtaining barrels of this type!

There is perhaps no one factor which is responsible for more failures in farm vinegar making than the common custom of using last year's vinegar barrels for sweet cider without even rinsing out the dregs of former years. Mere rinsing is not sufficient. They must be scalded thoroughly to make them fit for use. Fresh cider should never be put into anything but barrels which are as clean and free from microbes of all sorts as it is possible to make them, especially if no attempt is made to control the fermentation by adding large quantities of the desirable germs.

Never put either "mother" or old vinegar into sweet cider. The acid added or produced by the acetic bacteria of the "mother" is antiseptic to the yeast and is most sure to check or stop entirely the alcoholic fermentation.

Never put any fruit juice, or vinegar into a metallic container even for a short time as the acid present will corrode the metal, dissolving some of it. Such fruit juice or vinegar will always have an unpleasant metallic taste, and may cause metallic poisoning when used respectively as a beverage or condiment.

Fill of container: The barrel or cask of fruit juice, etc., for vinegar making should be filled not over two-thirds full, and placed on its side, bunghole up and open, for two reasons, namely: in the first stage of vinegar fermentation if the barrel is too full and too small a vent is provided, gas will probably be evolved so rapidly as to cause the loss of a considerable amount of the liquid; in the second stage of the vinegar fermentation, the acetic bacteria growing on the surface of the fermented liquid need a large supply of air in order to oxidize the alcohol to acetic acid. In either case the entrance of dust, vinegar-flies, and other insects should be guarded against by tacking a thin cloth over the bung-hole. To better ventilate the barrel for the acetic fermentation, a hole about $1\frac{1}{2}$ inches in diameter may be bored in each head of the barrel along the upper edge (see Fig. 5.) These holes should be covered with cloth also.

Temperature: Failure to put fruit juice, etc., at the proper temperature is perhaps the one great cause of failure in vinegar-making, taking everything else into consideration. We will say that the average farm vinegar-maker uses reasonably clean fruit, press and containers. On his ripe fruit are always found the alcohol-producing yeasts and vinegar bacteria in sufficient numbers to start off the fermentation in proper style. The fruit ripens and is very often pressed in the early fall when the temperature during a considerable portion of the time, is fairly high,

thus allowing the alcoholic fermentation to start and proceed more or less rapidly at first. Then the cider barrel is generally placed in an unheated cellar, barn or outbuilding, and as the cold weather sets in, the alcoholic fermentation is checked and perhaps finally stops entirely. Because of the fluctuating temperature which becomes lower as the season progresses the alcohol fermentation takes three to six months and even longer to reach completion. During this time any undesirable organisms present, which are favored by the low temperature, are developing, using most of the alcohol and remaining sugar; and by the time the alcoholic fermentation should be complete and the acetic fermentation start spontaneously, *nothing happens*, as the food material from which *Bacterium aceti* makes acetic acid, is exhausted. The liquid which was originally sweet cider is nameless; it is neither sweet nor "hard" cider, and never will "turn" into vinegar even if a favorable temperature is established unless sufficient alcohol or source of alcohol (sugar) remains and the right micro-organisms are present; this can be determined only by chemical and bacteriological analysis.

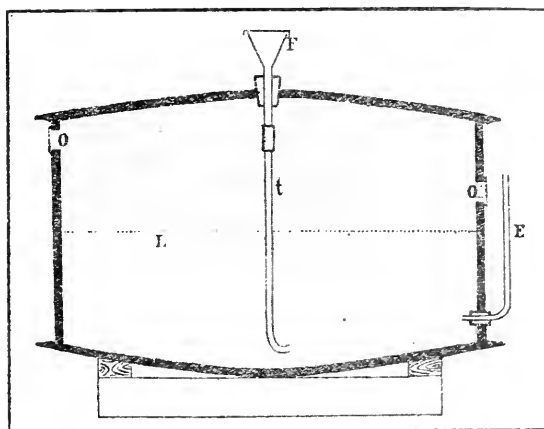


Fig. 5. Vinegar Barrel. L, surface of liquid; O, O, openings for circulation of air; F, funnel inserted through stopper in bung-hole, and t, glass tube fastened to funnel with rubber tubing, for introducing new supplies of fermented cider without disturbing the surface film; E, glass tube to show level of liquid and for drawing off vinegar. Keep this plugged with cotton to prevent the entrance of insects. (Fig. 142 from Marshall's Microbiology, 1917).

The most beneficial and practical range of temperature for the yeast to grow and produce alcohol is between 65 degrees and 75 degrees Fahrenheit. At temperatures much higher, there may result a loss of alcohol by evaporation. Happily the same range of temperature is very beneficial and practical for the acetic fermentation, thus the barrels of "hard" cider need not be disturbed if the temperature of storage can be regulated within these limits.

The yeasts and bacteria responsible for the formation of vinegar are plants, and like plants, must have a favorable climate (temperature), proper foods (sugar and alcohol respectively) in the soil (fruit juice, etc.) in which they grow, and the soil must be practically free from weeds (undesirable yeasts and bacteria) before the desirable plants can grow to the best advantage.

Length of fermentation periods: The lower the temperature, the greater the length of time necessary for each of the two stages of vinegar fermentation. In ordinary cellar storage it takes from one to six months for all the sugar to become converted into alcohol. By adding a pure culture of yeast to the fresh fruit juice and keeping it at 65 degrees to 75 degrees Fahrenheit, the period of alcoholic fermentation can be reduced one-half or more.

The acetic fermentation under ordinary cellar storage takes much longer for completion than the alcoholic; the time required may be all the way from a year to two or even three years. Such an extensive period of time is wholly unnecessary! If the acetic fermentation be controlled by the addition of a pure culture of vinegar bacteria and the temperature is favorable, market standard vinegar may be formed in a few months. Just recently several home vinegar makers have shortened the time of the acetic fermentation to about three months just by paying attention to these two things, inoculation with pure cultures and temperature. In the "quick vinegar process," the common commercial method of vinegar-making, the time for the acetic fermentation is shortened to a few days instead of taking weeks and months for completion. This quick process is described briefly on pages 509 and 510.

Storage of the finished product: When the acetic fermentation is complete, that is, when all the alcohol but 1 to 2 per cent has been converted into acetic acid, all bacterial and other fermentative action should be stopped; then it should be stored so as to prevent a decrease in acidity. As the germs which may destroy the acid need air for their development, it follows that a good method of storing the finished product is to fill the barrel or cask *full* of the vinegar, bung it tightly to keep out the air, and store in a cool cellar.

Better still, "rack" or siphon off the vinegar and store in a clean, freshly scalded barrel or cask, filling, bunging, and storing it as above. This vinegar if drawn off carefully should be perfectly clear and of a more or less amber color and will keep better than if left in contact with the dregs of the old barrel which consists of enormous numbers of living and dead yeast and bacterial cells. Racking off the "hard" cider into a clean barrel at the close of the alcoholic fermentation will eliminate these dregs to a large extent and insure a better acetic fermentation.

Clarification of vinegar: Vinegar as it is drawn off from the barrel or cask will be nearly clear if it has been made from a clear wine. If vinegar of extraordinary clarity is desired for bottling purposes, however, it will be necessary to clarify it by a special process known as "fining." The principle of "fining" is the same as that of using an egg to clear coffee. According to Bioletti* the best results are obtained by using isinglass. One-half to three-fourths of an ounce is employed for each one hundred gallons of vinegar.

"The isinglass is cut into small pieces and soaked for twelve to twenty-four hours in a little water containing acetic or tartaric acid equal in weight to the isinglass used. When thoroughly soft it is then rubbed several times through a fine sieve, gradually adding a little more water until a perfectly fluid liquid is obtained. This fluid is then well-mixed

* Bioletti, Frederick L., Grape Vinegar, Bul. 227, Calif. Expt. Sta., 1912.

with a little vinegar and thoroughly stirred into the cask. With some vinegars it is necessary to add a little tannin, from one-half to one-seventh the amount of the isinglass used. This tannin should be added at least twenty-four hours before the finings." Gelatin may also be used. For proportions see page 514.

"When the finings have settled and the vinegar is perfectly bright it is ready for bottling. The bottles after filling and corking should be pasteurized by heating in a water bath to 140 degrees F. Vinegar treated in this way will keep for years without deteriorating."

Pasteurization: After the acetic fermentation is complete, in order to prevent further fermentation changes, pasteurization is often resorted to before storing. This is heating the vinegar to 140 degrees F., a temperature sufficient to destroy all forms of life which would be injurious to the vinegar. During this heating the vinegar should not come in contact with metal of any sort. In the ordinary household, only the highest quality, unchipped and uncracked enamelware kettles should be used.

The barrels or casks in which the vinegar is to be stored should be clean and thoroughly scalded just previous to pouring in the pasteurized vinegar, filled, bunged, and stored in the manner before noted.

THE "QUICK VINEGAR PROCESS."

As the acetic bacteria need air to oxidize the alcohol in cider, etc., it is evident that in the ordinary vinegar barrel the surface of the alcoholic liquid exposed to the air is very small in proportion to the volume of the liquid. This is the reason why vinegar made by the household method is formed so slowly.

In the "quick vinegar process" the vinegar generator is so constructed as to multiply many hundred times the area of the surface of the alcoholic liquid thus increasing the activity of the vinegar bacteria by as many hundred times. The best type of "quick process" generator is constructed of a slightly conical wooden vat, having two perforated false heads, one near the bottom and the other near the top. The space between these two false heads is filled with shavings of beech-wood or strips of rattan which have been thoroughly extracted, first with water, then with good strong vinegar. (See Fig. 6.) Various substitutes for beech shavings such as corn cobs, etc., have been used with more or less success.

When the generator is in operation the alcoholic liquid is distributed intermittently by some automatic device over the top false head in small amounts. The liquid is supplied intermittently rather than continuously so that it will not tend to run in streams in certain parts of the vat and thus cause a loss of acetifying surface. If the flow is too rapid the bacterial film is washed down from the upper part of the mass of beech shavings and only the lower part is effective.

On the surface of the shavings, the vinegar bacteria grow in a thin membrane and as the fermented liquid trickles in a thin film over the bacteria, the alcohol is rapidly oxidized to acetic acid.

By the time the alcoholic liquid has reached the lower false head the larger amount of it has been acetified. It is generally necessary to pass the alcoholic liquid through the same vat from two to five times, or through a series of vats, to change all the alcohol into acetic acid.

The number of passages depends upon the amount of alcohol present, the rapidity of the flow, the temperature, and on the perfection of the apparatus.

The oxygen supplied by the entrance of air through a row of holes bored in the vat below the false head, passes upward through the mass of beech shavings to replace the air heated by the fermentation, thus a continuous circulation of air is insured.

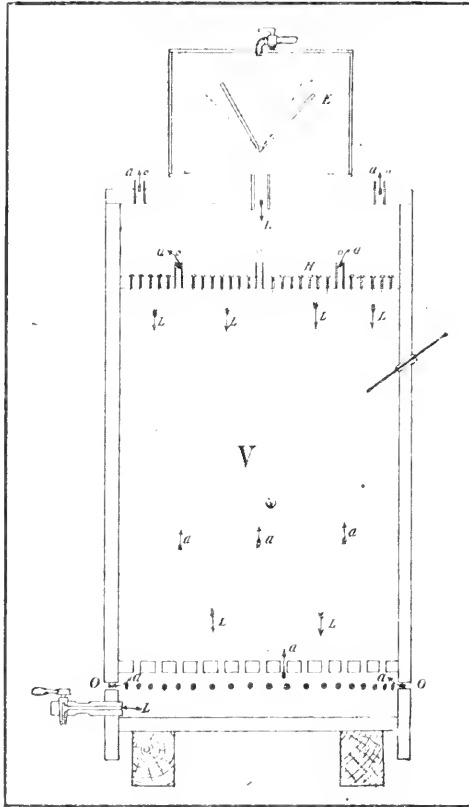


Fig. 6. "Quick Vinegar Process" Apparatus. V, mass of beech shavings over which the alcoholic liquid runs from H; H, false head with numerous small holes and threads for distributing the liquid slowly and equally; E, automatic trough for supplying the fermented liquid L, intermittently; O, openings for the entrance and exit of air; a, direction of arrows accompanied by a or L denotes the direction of passage of the air or liquid respectively; the thermometer inserted in the side of the generator enables the temperature to be read and regulated. (Fig. 143 from Marshall's Microbiology 1917).

The temperature must be kept close to 30° C. (86° F.) If it is too high, alcohol evaporates, often 15 to 20%, or even 30%; if too low, acetification is checked. The temperature is regulated by carefully adjusting the number, size and location of the holes through which the air passes upward.

Thus it is readily seen that the success of the quick vinegar process in brief depends upon furnishing sufficient surface to the vinegar bacteria that their oxidizing action may be exerted to its fullest extent upon the

largest possible amount of alcoholic liquid. In this way a certain volume of alcoholic liquid is changed into strong vinegar in a few days, which otherwise would take weeks and months, perhaps years to accomplish.

VINEGAR "DISEASES."

Off-fermentations: As has been before mentioned, the raw materials, e. g., fruit juices, etc., may often not "turn" into vinegar. This is probably due to "off-fermentations" produced by microorganisms. The only fermentations that should take place in vinegar-making are the yeast fermentation by which the sugar is changed to alcohol, and the bacterial fermentation by which the alcohol is changed into acetic acid. Other fermentations may occur before, during, or after these and are all to be avoided as harmful.

Mycodermae: If a fruit juice or other liquid strong in alcohol is left with its surface exposed to the air, it will usually in a few days be covered with a dull whitish film, thin and smooth at first but gradually becoming thicker, and finally rough and heavily wrinkled. This is the growth of yeast-like microorganisms of a type called *Mycoderma vini*, which develop only on the surface in full contact with the air, attacking the acid and alcohol, changing it all finally to water and carbon dioxid (gas), thus destroying the possibilities of vinegar ever being formed.

If this growth begins to form, it may be checked merely by the addition of a large quantity of a pure culture of acetic bacteria; the most sure method, however, is to draw off the vinegar, scald out the barrel thoroughly, heat the vinegar to 140 degrees F. to destroy the *Mycoderma* (only the best unchipped enamelware kettles should be used), return the vinegar to the barrel and when cool inoculate with a pure culture of acetic bacteria.

Acetic Bacteria: A film will often be formed on fermented fruit juices, etc., especially those low in alcohol, which is thinner, smoother, and more or less glistening, consisting of bacteria. These are the acetic bacteria themselves. Because of the low alcohol content the acetic bacteria can manufacture only a limited amount of acetic acid, but still needing more food they oxidize this acid into useless carbon dioxid and water, and again no vinegar is formed.

If this film is disturbed or becomes heavy on account of age, it sinks to the bottom of the liquid and there forms the slippery leathery mass familiarly known as "mother of vinegar." In this mass at the bottom of the liquid the bacteria are deprived of the oxygen of the air, and cannot therefore continue to manufacture acetic acid; then other germs may destroy it, producing substances of disagreeable tastes and odors, and in time cause putrefaction and destroy the flavor entirely. The sinking of the film may be prevented by floating it on a clean splinter of wood, or if the size of the bung permits, a little raft may be made. Nails should not be used in its construction.

Liquids low in alcohol are the result of the lack of sugar which may result from the use of unripe fruit; of ripe fruit low in sugar content; from a too great dilution of the sugary solution (honey, syrups, and the like); or from the presence and rapid growth of germs other than the

desirable ones which also use sugar as food, and are favored by low temperatures.

Other bacteria may produce injurious changes at the beginning before the vinegar bacteria have taken possession of the liquid. Their action is prevented by either adding 10 per cent of good vinegar, or by prompt starting of the acetic fermentation by means of a vigorous culture of vinegar bacteria.

Injurious bacteria may also attack the vinegar towards the end of the fermentation, producing putrid odors. These bacteria are prevented from exerting a harmful effect by promptly removing the vinegar to the storage casks as soon as the acetic fermentation is complete, by pasteurizing it at 140 degrees F., or by running it into barrels in which a stick of sulphur has been burned.

Controlling the vinegar fermentation: The vinegar fermentation is usually left to chance by the amateur vinegar maker. The commercial butter-maker now-a-days would quickly lose not only his prestige but his income if he went back to the old method of depending on chance for the flavor of his product. Modern commercial butter depends upon its uniform high quality for its market value. This is due to its uniform pleasant acid flavor which is produced by controlling the acid fermentation of the cream by the addition of pure cultures of bacteria selected for this very purpose.



Fig. 7. Pure Cultures for Vinegar Making. These pure cultures are growing in sterile cider.

By adding pure cultures which consist of enormous numbers of the selected germs, so many desirable germs are added that they crowd out

all others. Now this same idea can be applied to other fermentation industries with equally good results. For example, it has been found that wine, a product of alcoholic fermentation, can be standardized as to quality, flavor, bouquet, etc., by this very process of controlling the fermentation with pure cultures of a wine yeast; bread, another product of alcoholic fermentation has long been standardized by the use of pure cultures of the bread yeast which are sold as yeast cakes. Thus it is possible by the use of good yeast cakes for the housewife to make, almost without fail, a bread of uniform good quality. Why not, then, carry out this idea in vinegar fermentation? There are certain types of yeasts which produce much more alcohol than others out of the same quantity of sugar, and there are types of acetic bacteria which can manufacture a much higher percentage of acetic acid than others out of the same amount of alcohol. Why not use pure cultures of these best types of germs and produce a uniformly high quality of vinegar. Here is where the scientist comes in. The bacteriologist knows how to separate the good germs from the bad and indifferent ones, and how to grow the good germs in large numbers so that they may be used for a starter just as the yeast cake is used for bread-making. The Bacteriological Laboratory of your State Agricultural College is growing these pure cultures of yeasts and bacteria, for the very purpose of furnishing them to those who wish to make the best quality of vinegar. Two pure cultures (Fig. 7) one of a selected alcohol-producing yeast and one of selected acetic-acid-producing bacteria sufficient for a barrel two-thirds full of freshly expressed fruit juice or other sugary liquids, are furnished in order to control the vinegar fermentation. A nominal charge of twenty-five cents per culture is made to cover the cost of material and shipping. An application blank for these cultures will be found on page 496 of this bulletin.

Addition of vinegar for controlling the acetic fermentation: When the alcoholic fermentation is nearly complete, as a rule the acetic bacteria which are already present start to form the film or "mother" on the surface of the liquid. In order to give the vinegar a good start at this stage of fermentation, many farmers have the practice of adding two to four quarts of good cider vinegar containing more or less "mother," to each barrel. This practice is good or bad depending on the type of "mother" added. *Pure "mother,"* i. e., that made up exclusively of acetic acid bacteria, is a thin, white, glistening, gelatinous membrane that forms on the surface of vinegar. It seldom becomes one-sixteenth of an inch in thickness and should be translucent or white in color. On the other hand, the thick, tough, dark brown, slippery, leathery masses which form in vinegar and are usually regarded as "mother of vinegar" consist not only of acetic acid bacteria, but of yeasts and other bacteria, which may be actually harmful to the vinegar. It is to the harmful germs that the bad flavor in vinegar is due; they may also cause a partial or complete loss of the acid.

OTHER VINEGAR DISEASES.

Blackening: Vinegars, after making will often turn cloudy by the formation of a fine blackish precipitate on exposure to the air. This may be due to an *oxidase* which may be checked by adding 2 to 5 oz. of potassium metabisulfite per 1,000 gallons of vinegar.

It may also be caused by placing the vinegar in insufficiently cleaned new casks from which it extracts tannic substances which blacken on contact with the air. Contact with iron has the same effect. The acetic acid attacks the iron, and forms colorless iron salts which change to dark-colored iron salts on exposure to the air.

The tannins may be removed by treatment with gelatin (1 to 1½ oz. soaked up in warm water and added to 100 gallons of vinegar). This process is called *fining* and is merely a means of clarification, an application of the same principle as that of adding egg to make coffee clear. When the coagulum settles the clear vinegar may be poured off, casked and stored as usual.

In case of the iron salts, the vinegar should be well aerated in order to change all of the colorless iron salts to the colored one, then followed up by the fining process. The addition of a minute quantity of citric acid will prevent the recurrence of the trouble.

Animal parasites: One of the commonest and most-troublesome diseases of vinegar is caused by a nematode worm, the "vinegar eel." These are minute worm-like animals which can be seen easily with an ordinary reading glass, and even with the unaided eye by holding the vinegar before a bright light in a small glass.

They may be found in the vinegar barrel at almost any stage of the vinegar fermentation, sometimes even when the acidity is very high. They collect most numerous around the edges of the liquid and on the surface film and interfere with the acetic fermentation by destroying this film and causing it to sink. When numerous they are not only disgusting in themselves but their dead bodies undergo a putrid fermentation that may completely spoil the vinegar.

They are easily removed from the finished vinegar by filtration followed by pasteurization or fining, or by the addition of potassium metabisulfite. They are hard to control in the barrel. An infected barrel or cask should be emptied as soon as discovered, washed with boiling water and heavily sulfured. The source from which vinegar eels first come is generally river or surface water.

Vinegar mites are tiny animals belonging to the spider family. They often accumulate in moist places around the vinegar barrels and may even enter them, spoiling the vinegar if they are numerous. They can be destroyed easily with hot water and prevented from entering the casks by painting a ring of turpentine or kerosene oil around the openings.

Vinegar flies are also often troublesome, especially in warm weather. They breed around the openings of vinegar containers and wherever they find vinegar exposed to the air. If numerous, the maggots they produce may get into the vinegar and deteriorate its quality considerably. Cleanliness, and avoiding the spilling of vinegar and the leaking of casks are the methods of control. The openings of casks should be covered by tacking a thin cloth over them. This keeps out dust and dirt with their attendant micro-organisms, as well as insects.

FRUIT VINEGARS.

Apple or cider vinegar made from apple wine, popularly known as "hard" cider, needs no introduction nor further discussion as this is

the common farm vinegar of Michigan and its problems are dealt with fully in this bulletin. For profit apples should be expressed with a power press. With a hand press only 2 gallons of juice could be secured at the Virginia Station, while with a power press 4 gallons were obtained.

Grape or wine vinegar: Michigan has many vineyards; many of the grapes grown are unsuitable for marketing and can be converted into excellent vinegar. Such vinegar can be sold at a profit and at a price which formerly compared well with that of grape wine. On the open market grape vinegar can compete with other kinds when quality is considered.

Good grape vinegar cannot be made from moldy or decayed grapes. Its manufacture requires the same knowledge and care as with apple vinegar, and it can be successfully produced on a small scale for domestic purposes.

The quantity of vinegar obtained from various kinds of grapes differs due to the fact that the quantities of stems, seeds, skins, and fermentable sugars vary with each kind of grape. It has been found at the California Agricultural Experiment Station that one ton of grapes of 20 degrees Balling (20 per cent. sugar on Balling's saccharimeter) should yield on the average 135 gallons of vinegar of 9.8 per cent. acetic acid.

White wine vinegar, a light yellow vinegar, is generally recognized as the most superior of all vinegars as to flavor and bouquet. This vinegar is made from white wine, which is the result of the alcoholic fermentation of either the pulp alone of purple or red grapes, or of the whole fruit in the case of the white grape. The color of wine vinegar made from red wine is also red, due to the fermentation of the whole grape.

Of course, a fine quality of grape vinegar cannot compete in cheapness with that "made from distilled alcohol (the common incorrectly called "white wine vinegar" of commerce) or the numerous waste products which at present are the source of the main bulk of the vinegar found in commerce," but it most certainly excels it in flavor and bouquet. If grape vinegar "is to be produced at a profit, it must be made intelligently, and in such a manner as to produce and preserve those qualities to which it owes its reputation for superiority over all other classes of vinegar."

Peach vinegar: In seasons of heavy crops there are available large quantities of sound, overripe peaches which it will not pay to market as fresh fruit. Particularly is this the case when hot weather causes the fruit to ripen rapidly. The best peach vinegar will be made of fruit of this type. Rotten peaches, especially if the rotten spots are left on, make a poor vinegar, generally low in acid, with disagreeable flavors and after-tastes, which darkens rapidly on exposure to the air.

Peaches contain sufficient fermentable sugar for vinegar-making but they are on the average about 1 per cent. lower in their total sugar content than average apple juices. This, of course, results first in a lower percentage of alcohol, then of acetic acid than with ordinary cider. Average percentages of acetic acid in peach and apple vinegars are respectively 4.62 and 7.45 as determined by the U. S. Government. A large percentage of the sugars go to waste if peaches are allowed to rot before being made into vinegar, the sugar being used by the molds causing the rot.

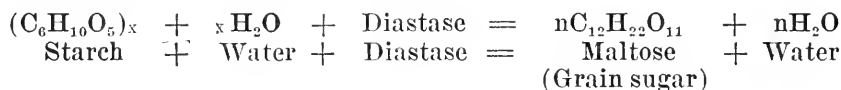
Pear vinegar containing 8.89 per cent acetic acid has been made (Oregon Expt. Sta.) within four months from the time the fruit was pressed by the use of pure cultures for controlling the successive stages of vinegar fermentation.

Prune vinegar of excellent quality has been made (also at the Oregon Sta.) containing 6.89 per cent. acetic acid. The only objection to it was its dark color. Undersized and otherwise unsalable prunes were used for the purpose. The prunes were first washed and then run through a home-made machine with spike-rollers which lacerated them. The pulpy mass was then inoculated with a pure culture of yeast which by causing a strong and rapid fermentation broke down the cell walls of the prunes, thus liberating the clear juice, which flowed into a receptacle below the vat. This method of securing the clear liquid was inexpensive and very satisfactory. A little more than 3 gallons of juice was secured in this way per bushel of fruit. Ten per cent of alcohol was formed in ten days, then the fermented prune juice was inoculated with acetic bacteria.

Other fruit vinegars: No extensive work has been done in the U. S. Government Experiment Stations on fruit vinegars other than those mentioned in this bulletin, with the exception of oranges. There is good reason for believing, however, that all fruits which contain sufficient fermentable sugars may be made into vinegar.

GRAIN VINEGARS.

Malt or grain vinegars require much labor and knowledge for their preparation because of the nature of the raw material. With this type of vinegars the raw material is starchy instead of sugary as is the case with fruits, and before it can be fermented to alcohol and later to acetic acid, the starch has first to be changed into sugar by diastase, an enzyme, which carries out this process during the germination of the grain, or by hydrolysis using steam under pressure.



Briefly the enzymic process preliminary to the acetic fermentation is accomplished as follows: first, a portion or all of the grain, is soaked in water, allowed to germinate and then dried. This resulting substance is malt. During this time the diastase develops. Then the malt is crushed, mixed with unmalted cereals or sugar usually, and heated with water during which time the diastase changes the starches into sugar.

This sugary solution can then be fermented successively with yeasts and with acetic bacteria to produce grain vinegar.

Malt vinegar is of a brown color and its odor is suggestive of sour beer. It is used largely in Great Britain.

Honey vinegar: Next to wine and malt vinegars in quality comes that made from honey. It is quite evident that honey has to be diluted to quite an extent before fermentation can take place. This dilution besides reducing the percentage of sugar in solution reduces also the

percentage of certain chemical elements necessary for the nutriment of the yeasts, consequently these have to be supplied in some form. The most important of these are nitrogen and phosphorus, which may be supplied as a food for the yeast in the form of ammonium salts and phosphates respectively. A formula which has been found to give good results experimentally is given below. It is sufficient for a barrel of vinegar.

Formula:

Strained or extracted honey	40 to 45 lbs.
Water	30 gal.
Potassium tartrate	2 oz.
Ammonium phosphate	2 oz.

The diluted honey should register 15 per cent sugar by the saccharimeter. As heat must be used to dilute the honey it will be necessary to inoculate this solution with a pure culture of the wine yeast and later with the vinegar bacteria as the heat employed will destroy practically all of the organisms already present.

Another formula from the Arizona Agricultural Experiment Station is as follows:

Strained honey	40 to 45 lbs.
Water	30 gal.
Ammonium chloride	4 oz.
Potassium bicarbonate	2 oz.
Sodium phosphate	2 oz.

Either formula will furnish sufficient food for the yeasts at a cost of about twenty-five cents per barrel. Of course, the larger the quantities made, the less will be the proportionate cost of the chemicals per barrel. These chemicals are absolutely harmless and cannot in any way be considered as adulterants.

Honey vinegar of most excellent flavor containing over 8 per cent acetic acid is being made continually from waste honey by the entomologist of this experiment station, using a similar formula. On page 505 the different kinds of unmarketable honey are given which may be utilized in this way.

Maple syrup vinegar: Dilute or boil down maple syrup until 15 per cent sugar is present (or until it weighs 9 lbs. to the gallon.)

Then use the following formula:

Diluted maple syrup.....	30 gal.
Ammonium sulfate	2 oz.
Sodium phosphate	2 oz.

and inoculate as with the honey vinegar. Skimmings from maple syrup, or maple syrup which is scorched or otherwise unmarketable can be utilized in this way to advantage.

Glucose vinegar is made from the acetification of alcohol obtained from the fermentation of commercial glucose. This vinegar usually possesses the odor and taste of fermented starch.

Molasses vinegar is produced either from the successive alcoholic and acetic fermentation of the wastes from sugar factories or of molasses itself. These two last mentioned vinegars are the types generally made with "vinegar bees."

Tomato vinegar: This type of vinegar requires the addition of sugar. The following method of procedure is suggested.

Select ripe tomatoes, wash thoroughly, blanch, cold dip, and remove skins (or pare, as most convenient), slice two or three times, place in an enameled pail and heat to the boiling point for a few minutes to extract the juice. Strain through clean cheese-cloth. Add 20 lbs. of sugar to each 30 gallons of tomato juice and inoculate when cool with the wine yeast. Just as soon as the active alcoholic fermentation has ceased, add a vigorous culture of acetic (vinegar) bacteria. It will be advantageous with this type of vinegar to add also at this time 2 to 4 quarts of strong cider (or other) vinegar to each barrel of juice to check the development of undesirable germs as is sometimes done with cider vinegar..

Although tomatoes not wholly suitable for canning can be employed for vinegar making, much care should be taken to thoroughly clean the fruit and remove any small spots as the flavor of this type of vinegar as well as its proper fermentation and keeping qualities depends very greatly upon absolute cleanliness.

Distilled, spirit, or alcohol vinegar: This vinegar is made by acetylating diluted alcohol and is nearly colorless unless artificially colored, as it often is, with caramel. When uncolored it is often incorrectly called "white wine" vinegar. The common white vinegar of commerce is this vinegar made from dilute alcohol and is in reality, nothing more than a dilute acetic acid. It lacks other than the acid flavor. The following table shows this clearly. Distilled vinegar is the vinegar used by the commercial pickle packers.

TABLE IV.*

White wine vinegar.	Specific gravity.	Total solids.	Sugar.	Bitartrate of potash.	Ash.	Acidity (as acetic)
Genuine.....	1.0175	1.93	0.22	0.17	0.32	7.38
Spirit vinegar.....	1.0100	0.35	Trace	.....	Trace	6.34

*From Leach's Food Inspection and Analysis, 3rd Ed. 1914, pp 762-3.

Other vinegars: There is no reason why a palatable vinegar cannot be made from sugar beets as a very satisfactory method of preparing sugar beet syrup has been published by the U. S. Department of Agriculture, (Farmers Bulletin 823.)

Vinegar of very good quality and high acidity has been prepared at this experiment station from the whey left from cheese-making, by the addition of a comparatively small amount of sugar and inoculation with a yeast which ferments lactose (milk sugar).

Vinegar has also been made experimentally from the alcoholic liquid coming from the silo during and after filling.

VINEGAR "BEES."

The use of vinegar "bees" is becoming more and more common so that a short discussion of them will be pertinent. They are generally added to a solution of sugar or molasses in water and set aside to ferment. The mineral salts in the water plus the sugar serve as sufficient food for the "bees." These "bees" are not insects but a mixture of micro-organisms, consisting of yeasts and bacteria, and occasionally molds. Certain of these yeasts and bacteria are of the type which working together will produce vinegar.

However undesirable germs are always present, many times in such numbers as to hinder the activity of the vinegar-forming organisms and consequently insufficient acid is produced. It is a waste of sugar to continue to add it to "bees" of this kind. It is very hard for the microbiologist to control with any certainty the activities of a mixed culture consisting of so many different kinds of germs consequently it is not surprising that many times the housewife does not always have success.

With an active culture of "bees", vinegar is often formed very quickly, in fact much more quickly than under the ordinary methods of vinegar-making. This can be easily explained, however. The housewife makes small quantities generally less than a gallon, and keeps the liquid in a glass jar in the kitchen where she can watch the activities of the "bees." The kitchen is warm, generally much warmer than the cellar where the vinegar barrel is generally kept, thus is much more conducive to rapid microbial growth than is the cellar.

Pure cultures under the same conditions prove much more satisfactory as the fermentation is under control. (An application blank for obtaining pure cultures is found on page 496.)

THE DETROIT COMMISSION PLAN OF CITY MILK ADMINISTRATION.*

Special Bulletin No. 99

By W. O. HEDRICK AND A. C. ANDERSON,
Departments of Economics and Dairy Husbandry.

The middleman dispute of recent years in which the farmer is seemingly made the dupe for the greed of the middleman class, has raged nowhere more fiercely than around the commodity, milk. On the one hand consumers of milk have been slow in sensing that milk is not merely a beverage but is a food of high nutritive value and, therefore, have opposed price increases in milk to the point of fury. On the other hand, farmers with large fixed investments in herds and equipments have found the costs of their dairy materials, cattle feed and expert help constantly rising, leaving them with no profits when milk was sold at the customary prices. In the same way city dealers have suffered from high costs also and have neither been able to give former prices to the consumer nor raise their payments to the dairyman producer.

The ruinous deadlocks or "milk wars" which have resulted in many milk centers from this state of things seem to be the natural outcomes from certain peculiarities in the fluid milk business which are not easily changed. It is the purpose of this bulletin first to describe these business traits which are peculiar to the milk trade and second to offer for their control the city milk commission plan the merits of which for this task will be shown to have no equal.

COMMERCIAL MILK.

The customary city and town demand for milk, while continuous, is as a rule extremely variable. It changes with the seasons and weather. The summer and hot days being the times of high demand, winter and cold days show a falling off. The average daily per capita consumption of milk with Americans is nearly a pint, so that naturally small units of milk are the customary deliveries of milk distributors. On the other hand, the dealer must be prepared to furnish large amounts, especially to restaurant and hotel keepers.

The town and city demand for milk too, includes a wide range of forms. Without the discussion of any of these in detail the naming of such varieties as "certified", "Class A", "Class B", "modified", "pasteurized" and buttermilk, together with certain natural associates such as cream, cottage cheese, and ice cream, gives some notion of the scope of this demand. In addition to these well-known and standardized varieties several of them have many subdivisions so that taste with

* The writers of this Bulletin desire to thank here Mr. C. H. Chillson of the Detroit Board of Health, for the able assistance which he rendered in gathering material for this study.

regard to milk products on the part of consumers is extremely marked.

The city demand for milk shows a ready reaction to changes in price, falling off with high prices and increasing with lowered ones. No one knows exactly the relation between price changes and demand shifts yet it is certain that milk holds no fixed place in the consumer's demand schedule as does, for example, salt. Squeamishness on the part of the consumer with regard to milk is perhaps more marked than with any other food product, yet the wishes of each consumer must be squarely met if a maximum marketing of milk is to result.

There is no wastage of rind or core or bone in milk and, as almost universally used, there is no household expense in preparing it for the table. Furthermore it is used as an enrichment or flavor with almost every kind of food. It is a product of the cold climates and the moist earth regions. The cities of the fiftieth meridian, reaching from Seattle and San Francisco on the West, to Petrograd and Moscow on the East, furnish the markets in which most of the fluid milk is sold. It will be seen at once then that within the world belt thus described are to be found nearly all the great centers of wealth and population so that milk is to be considered fortunate in having such a desirable market.

The growth of large cities in fact has given the fluid milk business its chance for growth, since villages and the open country are usually self sufficient in respect to a milk supply. The firm place which milk holds in our dietary, however, as a food which is good for grown people but indispensable for children, makes the problem of supplying a city extremely difficult and complex. Furthermore the problem is helped in no wise through the use of substitutes. Human wit has thus far found nothing which takes the place of pure milk, and human forethought must apparently take the path of breaking down obstacles between country and town rather than attempt the finding of milk substitutes.

The milk business, like that of railroading, cold storage or motor car manufacturing, is a distinctly modern business. One could scarcely think of milk handling in a commercial sense without pasteurization appliances, butter fat and bacterial tests, by-product utilization, distributing plants, etc., yet all of these are strictly discoveries or inventions of the past half century.

The consumer wants his milk regularly delivered and in small quantities. It must be regular because his uses of it are of the daily recurring kind. He favors a delivery plan rather than a carry scheme because the unit of purchase—usually a quart bottle—is too small to warrant the trip for it by the consumer himself, and he wishes it in small lots because he seldom owns a storage place for such a highly perishable commodity as milk.

THE DETROIT MILK DEMAND.

Michigan's great fluid milk market is the city of Detroit, and since the large size and rapid growth of this city are among the chief hindrances to an adequate milk supply these important subjects will now be discussed. Detroit as is well known ranks at present among the half dozen largest cities of our country and it has been hoped that a description of the city milk control here would prove helpful elsewhere under usual city conditions. The general milk market of the state, however, should first be given a glance in order that by so doing the especial needs of the metropolis may be put in their proper setting. In this survey of the state as a whole we may properly limit ourselves to that portion of Michigan which lies south of an east and west line passing a little north of Bay City, since this is the so-called "old-settled" portion.

The part of the Lower Peninsula thus named comprises, indeed, but little more than a third the size of the state, but in this area there are to be found 75 cities and large towns having an aggregate population of 2,000,000 or more persons. In addition to this there are in the small towns and villages of this area 150,000 more people to be supplied with milk.

Comparing now for purposes of illustration the city milk demands of Michigan with those of Iowa, Minnesota or Wisconsin, and we shall find that this small part of the state of Michigan which we have described has more than twice the city population of the entire state of Iowa. It also has in round numbers twice the city and town population found in the whole state of Minnesota. When the city and town population of this Michigan section is compared with that of Wisconsin, the commonwealth which it most resembles in natural features, climate, soil, etc., it will be found that this small portion of Michigan has in its cities and towns, one-half more people than the sum total of all the cities and towns of Wisconsin taken together. Furthermore, one cannot fail to note the fact that this territory is close to the great city of Chicago with its two and one-half millions of people, and that Toledo, which equals in size Grand Rapids, together with Cleveland which approaches in numbers the city of Detroit, are only a little ways to the south and east and that many residents of these three large cities get their milk and cream supplies from the herds kept on Michigan farms.

It will be seen, therefore, that the Michigan dairy interests are strongly of the whole-milk type. The states just mentioned are each her superior in some form of dairy product such as butter or cheese, but in Michigan the city demand has turned the bent of dairying decidedly towards supplying fluid milk for the city market.

Turning now to the big milk market—Detroit—we find that more than 100,000 gallons of milk per day are consumed in this city distributed by more than 115 milk dealers using a capital and equipment worth more than five million dollars. The Detroit demand requires that milk should come in many forms and products. Class "A" milk and Class "B" milk, frozen milk or ice cream, coagulated milk or cottage cheese, inoculated or butter milk, modified milk and certified milk are well-known types

among the many varieties which this city's taste requires. A recent bulletin from the United States Department of Agriculture entitled "The Market Milk Business of Detroit, Michigan, in 1915," to which we are indebted for the following data, makes the statement that consumers upon a typical retail milk route in Detroit will demand daily 256 pints of milk in quart bottles, 204 pints of milk in pint bottles, 19 pints of certified or modified milk, 22 pints of cream and 15 pints of buttermilk. Furthermore since there are nearly 300 customers upon a route, slightly more than a pint of milk products per customer is therefore used.

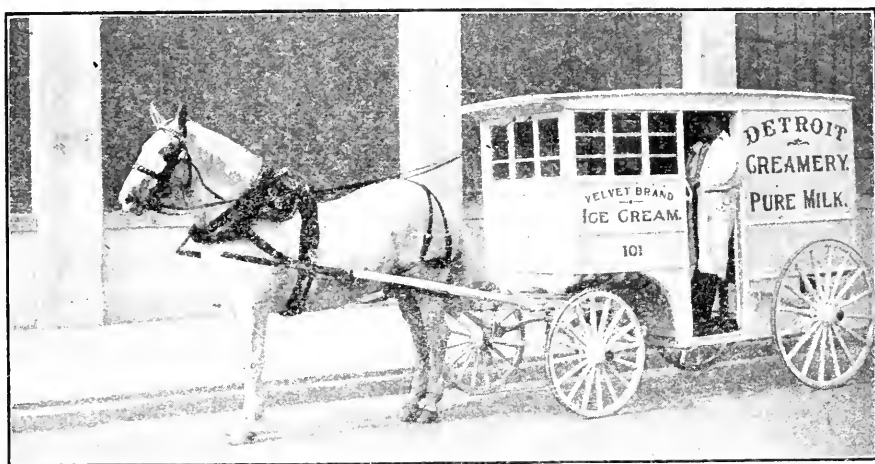


Fig. 1. Detroit uses 700 of these daily.

The agencies and appliances for distributing this vast amount of milk in so many forms during the few morning hours of each day over so wide an area as Detroit embraces and to so many people, must necessarily be extensive and elaborate. The agencies themselves are the well-known distributing plants, while the chief appliances are the still better known milk wagons with their suggestive letterings, and the ponderous milk trucks which carry the unprocessed milk from the railroad stations and attend to the wholesale trade deliveries.

The milk distributing plants indeed are more in the nature of mills or factories than that of depots or storage houses both on account of their heavy machine equipment and also on account of their large numbers of men needed as laborers. Since two of these plants alone have the capacity for furnishing nearly half of Detroit's milk supply, it may be well to describe milk distribution at its maximum by using one of these as the type and assuming a more or less close similarity on the part of the others. Our plant then being chosen, the fitness of its site may be accepted as settled by the two expediency rules of closeness to customers and to transportation and also by that of relative cheapness.

Whether so settled or otherwise, the city area or as much of it as may be purveyed to by the plant in question must now be plotted into routes for milk delivery having in mind all the savings which come from reaching the largest number of customers through the shortest possible hauls.

It is in fact in the plotting of these routes—each separate milk business of course having the right to cover the same city area with its wagons—that the most harshly criticized feature of the city milk business arises—"Cross hauls" as the circumstance is named of having many routes crossing and recrossing each other upon the same street, has long been blamed by the wrathful public as the greatest wasteful expense in milk distribution. Quite at variance with this popular belief, however, are the data with regard to milk delivery expenses in Detroit. Here it was shown that in 1915 the average costs of delivering a bottle was close to one and one-half cents—certainly not an enormous expense when compared with the trouble of helping one's self.

The functions of the milk plant itself when summed up in a single statement may be given as follows: To assemble the milk from the country, to suitably process and bottle it and finally to deliver it in response to the consumer's needs. These services are of a very modern origin. The early sources of city milk supply were from nearby herds—even, indeed from cows kept within the city itself—but with the demands of a growing city population, larger and larger amounts of milk were brought from distant places and the city milk plant came to be.

Upon arrival from the railroad station then at the modern city distributing plant the milk is first clarified by removing any traces of dirt which may remain after the transportation from the country. Immediately it is then pasteurized through slowly undergoing suitable heat to eliminate possible disease germs. Thence it is refrigerated to preserve it in the pure condition reached by pasteurization. Finally it is enclosed in the popularly acceptable pint or quart glass bottle, and is set aside in cold storage awaiting the call of the delivery wagon. Milk processing of this sort though expensive, is justified in the product and has done much to establish this food in the same esteem at the table of the city dweller that it has long had in the dietary of the farmer.

Naturally the costs and expenses of carrying on a business of this sort are similar to those found elsewhere in carrying on manufactories of like size and capitalization. Among the particular wastes charged against the business, that of bottle breakage or loss seems especially large. On the average a bottle lasts approximately 22 days so that a dealer with a daily 10,000 bottle distribution would, at the price these containers are usually held of 5 cents each, suffer roundly an expense of \$23.00 per day. Methods of paring down this great loss do not seem to come readily to hand. Non-transparent containers are not seemingly welcomed by the consumers so that bottle expense threatens to remain a fixed cost in the milk distributing business.

No other waste or "dead loss" expenses burdens the dealer so heavily, however, as does the familiar competitive one of over-stocking in order to have supply enough for all possible demands. Milk surplus, as this excess is named, is peculiarly typical of the city milk business. Other merchants may lay in their stocks of goods from day to day at will. They may countermand orders at the last moment or may store their over supplies. But none of these choices are open to the city milk dealer. In order to have an adequate supply of milk for all possible demands he must make contracts months in advance of delivery for the entire output from herds. He must stand by these contracts whether demand for milk keeps up or has ceased and he may not preserve his surplus in cold storage because city ordinances allow the sale only of fresh milk.

While "over stocks" or surpluses may come at any time in the milk business owing to the contract method of purchase, the spring surplus comes annually and is so large in amount as to seriously threaten the entire milk industry. This spring surplus is indeed sure to come furthermore because it is the result of the wide-spread winter dairy system of herd freshening and of the richer and bigger pastures of the early months. Annually, therefore, the dealer finds himself with a large surplus of milk which he must sacrifice to the manufacture of low profit by-products, such as butter, milk-powder, cottage cheese, etc. Some of the large distributing plants indeed find an average loss of a half-cent per quart of milk from this source, and all stand a loss of some amount.

Many cures have been suggested for this evil. The summer freshening of herds has often been spoken of as a possible remedy. Lactation would then, of course, stop during the spring surplus period and the fall milk shortage would be helped with more summer-freshened herds. On the other hand this would throw milk production into the wrong season for the farmer owing to his heavy summer labor schedule, his poor summer pastures and the bother of insect pests. No farmer would find it profitable, therefore, to undertake summer dairying and thus check the spring milk surplus unless a sufficiently high price were offered him to pay for the extra costs.

Another remedy is that of whetting demand at the surplus times by much advertising. This seems wholly practicable if done jointly by the dealers and producers for a given city. A union of both these groups in this way makes a monopoly, and any benefits from advertising by such a unit would fall upon no one but its own members. The great expense of advertising and the satiety point in milk demand are seemingly the only checks to this plan.

THE DETROIT MILK SUPPLY.

The milk sheds or farming areas from which cities secure their milk supplies are extremely variable in size and in permanence. This shed so far as Detroit is concerned is markedly unbalanced since, owing to the nearby Canadian boundary, no milk is shipped from the east into this city. On the other hand some milk supplies from the northwest travel many scores of miles, though it is probable that the average distance covered is not more than fifty miles. Appreciable quantities of milk furthermore neither originate within the city itself nor even near enough for profitable delivery by the farmer producer.

Within the country area supplying Detroit, milk is sold in general by the specialized farmer to whom dairying is the main task though a relatively small part is still had from the general farmer to whom dairying is a side line. The membership rolls of the Michigan Milk Producers' Association show a list of 8,000 farmers who are producing milk for the Detroit market. The equipment, generally speaking, of a milk-producing farm besides the herd and barns consists of a milk-house or cooling-room with a supply of ice, milking pails, aerator and the 10-gallon milk cans. Dairy barns must comply with certain rules as to light and air, while equipment is scored high or low according as it is well designed and cleanly.

The Detroit milk shed, one-sided though it is as the result of boundary

line hindrances, falls far short of giving its entire product to the metropolis. Within the area which makes up this shed, there are of necessity many creameries, several condensaries, and a few cheese factories. Other large cities vie with Detroit also in getting milk from this territory, notably Toledo, Cleveland and Chicago which lie upon the border of this milk shed and toward which milk and cream may be directed with every favorable turn in price. The cities of Flint, Port Huron, Jackson, Ypsilanti, Mt. Clemens, Adrian, Ann Arbor, Pontiac and Monroe are squarely within the Detroit milk shed itself and secure part or all of their milk supplies in competition with the metropolis. The evils in city milk price control, which arise from the fact of so large a number of competitors for the same supply, will be pointed out more fully in the later discussion of the milk contract.

The gathering and moving of milk over so large an area as comprises the Detroit milk shed is naturally a task of no small size. The work must not only be done rapidly, in order that the milk may not become over-exposed, but it must be done in a cleanly way and it must be done as cheaply as possible. It is demanded by consumers of milk that their supply not only shall be pre-cooled by the dairyman but that it shall also remain cool until delivered, and these services add no small burden to the expense of milk gathering and delivering. Milk may be said to be sold customarily at the dealer's receiving station or shipping platform. This is true even though the control of the country milk haulers themselves is in the hands of the milk dealer, who arranges the routes and charges the producer with the cost of hauling.

The shipping point, whether upon the railroad or upon the interurban, has at least a platform from which the heavy cans can be more easily loaded into the waiting car. At important shipping points the large city milk dealers usually place receiving stations, which, in some instances, are small scale copies of what the city milk plant is itself. Customarily, at all these stations, milk from the hauling wagons is received and the used cans washed before returning to the farm. In all of them also, there are storage facilities for holding milk until shipment to the city takes place; also testing appliances and business offices for the city dealer's agent. But in many of them, too, there are also appliances for butter-making, cheese-making, milk powder manufacturing and milk condensing. These facilities serve the very necessary purpose of using up the surplus of milk not needed by the dealer for city trade, but which, owing to contracts, the producer has the right to deliver. No small saving is in this way made by the local milk station, since much milk is kept by these means from shipment to the city at the heavy charges for rail carriage and city haulage.

The trip to the city is sometimes made by the use of especially planned cars with especial cooling and handling outfits, but more often it is made through the use of the baggage car of the ordinary fast passenger train or interurbans. Motor trucks in the cases of the shorter hauls are becoming very acute rivals to the interurbans and railroads in their milk carrying business.

MILK INSPECTION.

One of the first signs that milk was looked upon in a different way from other foods by the city consumer, was the wide-spread adoption of city ordinances a few years ago, fixing the village and city qualifications which milk must have in order to be salable within city limits. The Health Board of Detroit began the oversight of this matter shortly after the residents of the city ceased to rely upon their own cows for a milk supply but it was not until 1911 that a well worked out plan of milk inspection was given effect. City dealers were licensed for the first time by the Board of Health upon this date and a United States score card for dairymen was adopted and enforced upon the thousands of country producers.

The fact that milk is generally consumed raw has made the matter of its purity vastly important to the consumer, wherever this food has become an article of diet. Adulterations of various sorts made up its first general abuse, but these gave up in the main to the skill of the Babcock test in separating out the genuine parts of the milk from the fraudulent or added parts. Harmful preservatives came next and had their share in damaging the food value of milk, but these have long since been overthrown by chemical tests, until formaldehyde and its allies have no further menace to clean milk.

The infectiousness of milk has also been one of its weak sides. The capacity to carry tubercular germs which Koch found to be true in the late nineties proved a powerful check to the use of fluid milk, until the findings of the tuberculin test at last curbed everywhere the danger of harm from this source. But the liability of milk to infection from almost every bacilli evil which it touched, made it still a carrier of typhoid, scarlet fever and small-pox germs until the service of pasteurization robbed these dangers of their threat. As late, indeed, as 1914 Detroit had not seen the way clear to require pasteurization for its entire milk supply, but with the spring of 1915 this requirement was enforced. The last pure milk triumph is the mastery of other possible sources of contamination through the use of clean milk receptacles, clean methods in the dairy and small topped pails in the stables, through the use of bottles in delivery and above all by the use of the "bacterial count", and sediment test whereby dirt is at once discovered and its amount measured and quantitatively stated.

These precautions and safeguards must all be got by wise laws and active care on the part of public authority. The state of Michigan has passed laws defining milk and fixing penalties for its abuse but the use of these laws in the area under discussion rests with the Detroit Board of Health. Fortunately, this body through its directing specialists and staff of inspectors is well equipped for bringing the milk used in Detroit up to acceptable modern standards.

MILK PRICES.

Milk prices fall naturally into two well known classes—those received by the farmer from the city dealer, and those gotten by the dealer from the city consumer. The former is usually quoted in terms of hundred weights, the latter in terms of gallons, pints and quarts. This last amount is the customary quantity bought by the Detroit consumer, and the price quoted for a quart of delivered milk is usually a computed advance upon the price which the city dealer must pay the producer. The hundred weight price, however, both because it deals with larger

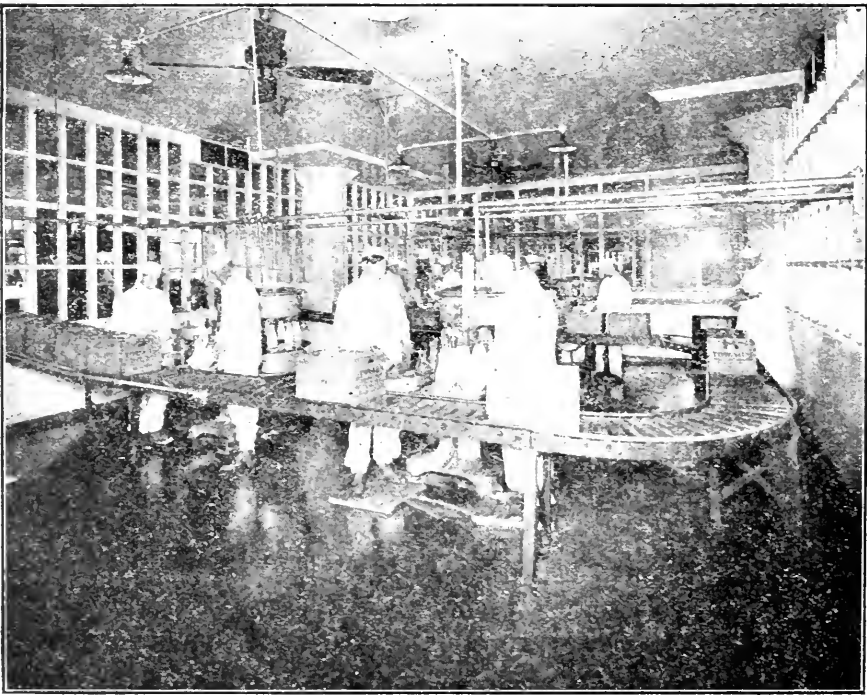


Fig. 2. Bottle filling department of a large milk plant.

amounts of milk and also because it is arrived at by conference, is the more important price of the two and will, therefore, be the one referred to in the rest of this discussion.

Commercially speaking, milk as an article of trade belongs to the perishable class of foods. This means that it is marketable only in the locality where it is produced, needs vast and costly equipment in being marketed, and is a part of that class of food stuffs which is fast taking first place on the tables of consumers. The marketing possibilities for raw milk while steadily widened during recent years through the

growth of a better and faster transportation service are nevertheless at bottom strictly local in their range. There are for example no City Produce Exchanges anywhere upon which milk is bought and sold in the way in which farm staples are bought and sold nor any large shipments of milk from city to city nor any nation-wide dealings in milk of any sort. Furthermore, while means of transportation have helped to some extent the natural field for broad milk marketing, city regulation of milk supply has served in practice to limit the sources from which a supply may come, so that the fact still stands of a fixed city dependence upon a single country area for a supply of milk.

The fact of this limited market for milk, which has just been described, gives rise to at least two further peculiarities of milk selling, as compared with the selling of other farm products, which deserve attention. The first of these is the circumstance that the milk supply of a city may be easily monopolized by its producers. This milk has at the time of its production a fixed city destination owing to the Board of Health inspection which it undergoes. It has no competition from other milk areas on account of its frailty in shipment and it therefore becomes for any city a definite and tangible supply drawn from known and fixed sources. Under these conditions the producers of milk have only to organize and a monopoly of the milk supply of any city is strictly within their hands.

Secondly, the contract method of sale between producer and dealer, which is the fixed method of selling milk in the milk trade, stands in marked contrast with the open competitive method of selling other farm products. Contract selling of milk is indeed obligatory upon the producer in view of the big fixed outlay relative to daily output which is found in a dairy herd and the further fact of the frailty of the product. Every sale of milk by a producer is a forced sale, since milk is so perishable and so limited as to market that it must be sold as soon as produced. Under these conditions the dairyman can only secure his rights by having them stated in a contract. On the other hand, the dealers anxious to have an adequate and reliable supply of milk and buying only from a limited and inspected or authorized area of milk production, readily gives these contracts, since he too wishes to safeguard himself from irregular or new competition.

The milk contract then, which is the basis of trade between the producer and the distributor is indispensable. Contracts of this sort have in brief the following features, so far, at least, as those used by Detroit dealers are concerned. They refer always to the price of the milk, the grade, and usually to the place and times of delivery.

Discussing these items in order we find that the milk prices stipulated by milk contracts belong to that class known as prices made by agreement. Customarily the dealer announces a periodical price which he is willing to pay, being scaled up or down for the different periods of the year in accord with the milk flow or shortage of the various seasons, and the varying demands of the city consumer. Thus the price is always low for the spring months, while the winter and fall prices usually range toward the maximum. Prices also are influenced by the distance over which the shipments must be made in order to reach market, and by the circumstance as to whether or not there is local competition. Local competition springs from the demands of nearby condensaries, local creameries, or the bids of competing cities.

All of these rivalling forces were active upon the Detroit milk shed, and played their part in fixing milk prices.

The matter of distance from market is more under control than that of competition, and therefore, the dealers always fix an orderly scale of distances or "zones" in which deductions from the city price will be made in order to cover costs of transportation. Thus by way of illustration, for distances between 1 and 25 miles, 15 cents discount is allowed; 25 to 30 miles, 20 cents, etc. These deductions are frequently shifted as railroad charges go up or down.

Price stability both of retail prices and also of those per hundred-weight is an indispensable condition in the milk business. The consumer likes price uniformity in milk because it saves him the trouble of daily bargaining for this necessity. Like his gas bill or water tax he knows before hand what his milk outlays will total and this helps in planning the household budget. Between the producer and the distributor stable or uniform prices are equally essential since the relations between these two are fixed by contract and naturally no contracts could be written if daily shifting prices were the rule.

WAR AND MILK PRODUCTION.

The almost immediate effect upon milk production coming from the war was the great rise in production costs which grew out of the alarming increases in the prices of feeds and dairy equipments during this time. Partly on account of the greater direct demand for animal feed caused by the war and partly as a sympathetic result from the increased demands for human food, which the war brought about, cattle feed and supplies of every sort became ruinously expensive. The world's stock of nutritives was indeed almost depleted and cattle feed prices soared. Milk per ton and feed per ton were soon selling at the same price in many places.

The losses from low milk prices and high milk production costs suffered by the dairyman during this period are well shown by a table covering two years made by the Dairy Department of the Michigan Agricultural College which is as follows:

TABLE SHOWING MONTHLY COSTS OF PRODUCTION FOR 3.5% MILK —AVERAGE
OF 25 FARMS NEAR HOWELL—AND PRICES PAID FOR 3.5% MILK AT THE
HOWELL CONDENSERY DURING THE SAME MONTHS.

Date.	Cost of Production per cwt.	Paid by the Howell Condensery per cwt.
1916.		
March.....	\$2.19	\$1.59
April.....	2.20	1.51
May.....	1.63	1.30
June.....	1.39	1.21
July.....	1.83	1.32
August.....	2.31	1.36
September.....	3.18	1.46
October.....	2.67	1.71
November.....	2.70	2.01
December.....	2.39	2.01
1917.		
January.....	2.21	2.01
February.....	2.17	2.20
March.....	2.24	2.07
April.....	2.36	2.00
May.....	1.78	1.70
June.....	1.49	1.75
July.....	1.76	2.10
August.....	2.44	2.40
September.....	3.16	2.40
October.....	3.46	3.00
November.....	3.42	3.00
December.....	3.28	3.10

Since as shown by these data, there was an acute rise in all costs to the dairymen during these months, it was soon clear that there must be a boost in the selling price of milk, or dairying would be abandoned.

Several plans for getting bettered conditions were used by the milk producers, all of which offered hope but none of which were wholly satisfactory. The milk dealers themselves could do nothing in the way of relief. The rapidly rising costs of labor, machinery, horse feeds, bottles and other necessary supplies were as hard upon the dealer as similar rising costs were upon the dairymen. The distributor had no receipts with which to pay a higher price for milk unless he too were content to carry on business at a loss. Co-operative creameries or butter manufactories were started in some places as a means for giving a new outlet to the dairymen's milk supply. But the dead level of maximum prices beyond which the price of butter can not rise—owing to the rivalry of substitutes—made this even a less profitable way of selling milk than that of the city market. Co-operative distribution by themselves of city milk was loudly advocated by many dairymen and was tried in some instances. But a peculiarity of milk distribution is that it requires a very costly city plant and a very costly delivery equipment for its success. Dairy farming itself is one of the most costly types of agriculture and to require milk producers to provide capital for both branches of their industry was a load beyond reason and too heavy to be carried.

Everywhere gatherings of dairymen were held to talk over common wrongs and it was soon plain that united action of some sort would be the chosen remedy. Among the first striking moves along this line

were the agreements among producers in certain districts to stand firm for a set price. But the legality of such "restraint of trade" price-fixing attempts was more than doubtful and hopes of help from this source were soon given up. Milk producer's associations in which milk selling was to be done as a unit through a common salesman, in a word "collective bargaining," offered another plan from which help might come. Since associations of this sort were by far the most successful of the various schemes used, a fuller discussion will now be made of their beginnings and successes.

THE MICHIGAN MILK PRODUCER'S ASSOCIATION.

The speed with which associations of this sort were begun during the last months of 1916, and their certain promise of success makes it worth while to show again the solid basis upon which they stand. Dairymen selling milk to Detroit, it must first be remembered, were already in part organized or at least drawn together through the privilege given them by the Detroit Board of Health of being the only dairymen who could ship to the metropolis.

Secondly, milk being highly perishable, could not be shipped over long distances, and therefore, roughly speaking, must be sold to and bought only by Detroit. Thirdly, these producers while numerous, lived fairly near each other in a compact area, sold milk to the same city dealers and, therefore, were known to each other through a common interest so that united action was easily possible. Fourthly, the custom of contract sales between dairymen and city dealers made price conferences a necessity and this helped toward organization.

The condensaries were the first to feel the brunt from these new associations of dairymen. In the winter of 1915-16, meetings were held among the condensary patrons in all parts of the state and more or less stable local unions were formed. Besides the prime matter of milk prices stood for by these organizations, some minor subjects such as those of milk quality and the recognition of the associations by the condensaries, were debated.

In May, 1916, at the call of several local dairymen's associations a general meeting of dairymen from the whole state, met at the Agricultural College and the first formal step was taken toward the getting together of all Michigan milk producers. In October of this year a still larger meeting of dairymen met at the same place where a permanent state association known as the Michigan Milk Producers' Association was formed, a salaried secretary was chosen and a price at which milk could be profitably sold during the coming year was suggested.

Fortunately the city dealers had already formed an organization under the name of the "Detroit Milk Bottle Exchange". This association, as its name implies, had for its purpose the very practical end of recovering strayed milk bottles. This end could not be reached, however, without many meetings together of the various dealers and these gatherings became the means of united action for these middlemen. Action of this sort was soon demanded, indeed, in order to reduce the clamor of the producers' association for a much higher milk price than hitherto had been the rule. In the price dispute which followed each association spoke through its agent and in the resulting parley the well known principle of collective bargaining had its first triumph as a means of settling milk prices in Michigan.

The business-plan of the Michigan Milk Producers' Association is strictly a growth from necessity. Of its many thousands of members, 8,000 at least, making up more than half of the entire membership, sell to the Detroit Market. These act as a unit in allowing the secretary of the association to contract their milk to the Detroit dealers. Membership in the association is got by dairymen in the Detroit area through a written promise to the association officials to submit to its rules—especially those in respect to milk sales and to pay an annual fee.

Even this fee shows the good sense which has thus far been unflinching in the workings of this association. As every one knows the direct collection of a fee from a membership of so many thousands would be difficult and involve an enormous expense. The whole of the 8,000, however, sell to the Detroit milk dealers and the plan was at last hit upon of getting through these dealers the payment to the association treasury of one cent per hundred-weight from the milk sold by each country patron. A well filled strong box is thus given to the Milk Producers' Association which has helped much to its usefulness and permanency.

The general purpose of the association as summed up in its by-laws is to "stabilize the conditions of milk production". It is safe to say that its success has gone far beyond all hopes.

THE DETROIT MILK COMMISSION.

Helpful as collective bargaining had proven to be in its first use as a plan for settling milk prices, such employment in its simplest form in this field was short-lived. Badly as war conditions had raised costs prior to the entry of the United States into the war, it was the food shortage year of 1917 which was to prove epoch-making in this respect. The retail price of milk to the Detroit consumer by midsummer of this year stood at 12 cents per quart with a certainty that with rising costs it still must go up. In this dilemma disputes between the producers' and the dealers' associations faded away in view of the paralyzing milk prices which consumers would soon be asked to pay. Both associations found themselves in fact in full accord in asking for a commission which would deal with the difficulty. Indeed, it is only frankness to say that it was thought that by means of a commission the coming high prices which the consumer must pay, might seem more just to him and thus the gathering storm from that quarter would be allayed.

Fortunately the germ of such a commission was already at hand in the form of the State Dairy Commission of five men which had been appointed by Governor Sleeper earlier in the year to study the entire dairy industry of the state with a view to its proper up-keep during the war. To these now were added by assent of the two associations as speaking for Detroit's interests, J. Walter Drake of the Board of Commerce, Mrs. R. M. Grindley, Detroit Federation of Women's Clubs, and Frank X. Martel of the Detroit Federation of Labor. The membership of the original commission of five consisted of Ex-Governor Warner, State Board of Agriculture member Waterbury, Dairy and Food Commissioner Woodworth, State Market Director McBride and Michigan Agricultural College Professor Anderson. Every milk interest and the public at large were given a vote in this commission and it will be seen by a study of its membership and there was also good luck in the fact that the country members were all trained and experienced dairymen.

Commissions with wide powers are a common remedy for public ills and the Detroit Milk Commission took a place in the same class with the many other food, fuel, industrial and war commissions by which the public are served. It took upon itself at once through the force of its membership the work of an executive board. "Its first duty", so an early report states, "was to see that Detroit had an adequate and dependable supply of milk." It was to handle milk for Detroit like a water board handles water, or a gas board, gas, and it was justified in looking upon milk as a city utility to be handled in this way for the following reasons:

First, milk is a public utility to cities because it is universally used upon the tables of city people. This popularity of milk is strikingly shown by a report made to the Federal Bureau of Labor by a food consumption survey board in 1903. In this report we find that among the families studied—mostly workmen's families—96.61 per cent paid out money for milk, while 76.49 per cent stands for the families buying bread, the so-called "staff of life". (18th Annual Report, U. S. Bureau of Labor, page 492-493.)

Second, milk is a public utility because babies cannot live without it. No city could avoid an abnormally high infant death rate, if it lacked a supply of good milk. There are no substitutes for milk of any sort in the dietary of the child, and there is no other adequate source for a supply than that of the herd.

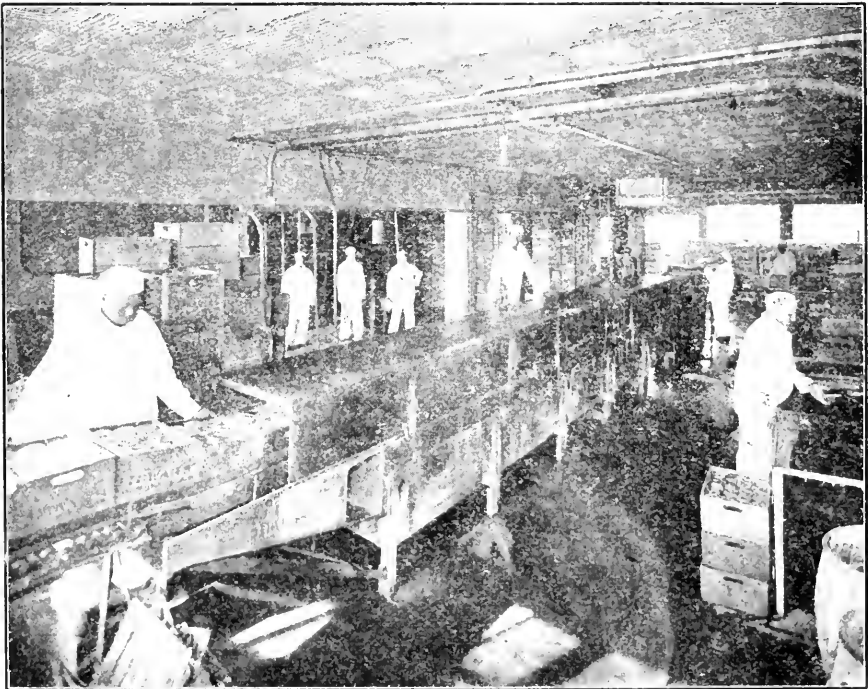


Fig. 3. Bottle washing department of a large milk plant.

In the third place, cities have accepted everywhere, the responsibility for a milk supply to their citizens. This they have done through forbidding private persons to keep cows within city limits and thus supplying themselves with milk. Restraints of this sort always throw it upon the public to make good the hardships caused by such action.

In the fourth place, city action is necessary in the case of milk in order to guard city health. Milk may be a bane as well as a blessing. Its rich, opaque, liquid substance may make a perfect culture for vast numbers of malady carrying bacteria. The sanitation of milk has indeed been the one side of this food which has had public interest and respect, and as a result, milk retailers are usually licensed.

Fifth, there is no other way to get a satisfactory supply of milk for a city than through city action. The consumer may be left free to buy at will most of the foods which go to his table but this is not the case with milk. Few food stuffs may be more tricky and the consumer is wholly without light as to the quality, grade and value of milk unless the city gives him help. No single consumer, for example, should be asked to own and use the chemical and bacterial tests by which good milk is told, when cities acting for the whole may own and apply these tests at the minimum of trouble and expense. A city need of this sort may very properly, therefore, become the object of a commission's care and effort.

THE JUST MILK PRICE.

The second task which the commission took up was that of making milk prices which should be just to the consumer, the dealer, and the producer. Here it was soon plain that the corner stone of a just milk price, in the judgment of the commission, was "costs of production"—using this term in the broad sense as including also costs of marketing. No other sound conclusion, indeed would have been possible. No consumer is wronged in paying fully for all the real costs, expenses and pains which have been spent in fetching him the thing he uses. The use by the city of a food necessity like milk merits the complete repayment to the producer of every actual sacrifice, expense or cost made in the making and care of this milk if the city hopes for an adequate supply and quality to be kept up. Happily for the commission the price slogan of the day "costs of production plus a reasonable profit" was very widely believed in.

The commission had its first meeting in the Board of Commerce rooms in Detroit, November 23, 1917, and held an open session for five days. Representative members from both the producers' and the dealers' associations were at hand to inform the commission as to costs in both of these sides of the milk business and much discussion took place. Of far greater help, however, than this general testimony upon costs, were two other sources of information, the use of which by the commission has made its findings upon milk prices fairly final. These were a Study in Costs of Milk Production made by the Dairy Section of the Michigan Experiment Station, and a Cost of Milk Distribution Report made by a firm of certified accountants from the bookkeeping records of the leading milk dealers in Detroit.

The study in costs of production had reached back over a period of five years prior to its use by the commission. It had covered during this

time the items of cost in 50 herds, situated in a typical milk producing region within the Detroit area. The Experiment Station had given the entire time of three men to this study, and the work had been extremely well done. A national conference of farm cost accountants in July of 1917 had accepted its methods, and the Hoover Milk Commission in December of 1917, in making a report, adopted its returns.

The inquiry of the certified accountants into the costs of milk distribution had also been able and thorough. Indeed, no other item of expense under the commission's direction has been nearly so large as that which was made upon the treasuries of the producers' and dealers' associations in getting this report.

That milk prices were too low was soon plain to the commission. Not only was the testimony of dairymen and dealers unanimous on this point, but the records of the milk costs study showed that in only four months of the past year—1917—had the price of milk to the farmer equalled its costs.* In fact during some months the wholesale price had failed by 80 cents per hundredweight to equal costs of production. The decision by the commission, therefore, that the producer should have roundly \$3.35 per hundredweight in place of the November price of \$2.60, and the dealer 14 cents per quart in place of the previous price of 12 cents and a proportional raise in bulk or wholesale milk met everywhere with satisfaction.

The Milk Producers' Association took cheerfully the award of the commission, since it marked a 75 cent raise per hundredweight over the receipts per hundredweight of the month before. The dealer had his usual profits through the higher price per quart which had been given him, and the consumer seemed satisfied with the situation also—prices of other things had gone up—Detroit was a very prosperous city—and, apparently, the unusual price of 14 cent milk was borne without general complaint or feeling anywhere.

Several other methods of making milk prices besides that of production costs were open to the commission and since one of these was urged persistently both before the commission and in the press, some attention should be given to its merits. Milk prices it was widely claimed, could be found out by using butter and cheese prices as guides toward that end.

A scheme of this sort for reaching a proper milk price is very simple. Having given the price at which butter and cheese is quoted in the market reports, a simple calculation gives the value of the milk which has been used to make this pound of butter or cheese. Butter and cheese prices, it is urged, are model prices because they are gotten through regular market processes spread over the whole country and thus reflect the real value of the butter-fat element of milk.

On the other hand it is doubted whether the price of this single element of milk should have the last word in fixing the price of the whole. Butter fat indeed represents but one-half of the food nutrients in milk and the other marketable elements such as caseins and milk sugar should have their influence in determining prices. Butter fat, furthermore, as is well known, has its own market, its own competitors such as butter substitutes, its own marketing expenses, middlemen and methods—all of which are very different from those of fluid milk.

* See p. 531.

Butter fat production even is a different sort of dairy farming from the production of city milk. Milk for the city comes from the herds of specialized dairymen using costly equipments under inspection and is a daily whole year round task. Butter fat production is usually a side line to some general farmer, is uninspected by city health boards and may be done in the favorable times of the year only; since butter fat is easily kept in cold storage. The important differences between butter fat and fluid milk are plainly too numerous to let the price of the one fix the price of the other.

Under the conditions prevailing in the Detroit area, cheese price quotations would be a less safe guide than those of butter in reaching a just price for fluid milk. Two-thirds of the food nutrients of milk are indeed used in the making of cheese but the business itself is not carried on within the area purveying to Detroit and the few other regions of Michigan in which it is practiced are too remote to supply any considerable amount of milk to the metropolis.

At the subsequent meetings of the commission, milk prices were set at new amounts so as to follow seasonal changes in costs of production and other altered conditions. An interesting test was begun at an early meeting to try out the merits of the "cash and carry" retail scheme as applied to milk marketing. The most discussed point in the distribution of milk is the plainly heavy costs of making deliveries from house to house. The commission provided for four stores in suitable parts of the city where consumers could buy bottled milk at three cents per quart less than the price at which milk was delivered. The bottle loss which totals up so heavily against the dealer in the usual system of milk handling was to be stopped under this plan by making the milk buyer return a bottle at each purchase or else pay for a new one. No large amount of interest in this experiment, however, was shown by the consumers and after a few months it was dropped.

THE MILK SURPLUS.

Another problem second only in importance to that of milk prices was that of the milk surpluses and shortages and this was taken up by the commission at an early meeting. Milk surpluses and shortages as these annual over supplies and deficits are called which occur in the milk trade of every city are the result of a natural misfit between the city's demand for milk and the country supply and their banefulness can scarcely be over estimated.

The city consumption of milk while continuous from day to day the year round is very much greater during the summer and fall months than in the spring or winter. Natural conditions are the cause of this since the warm weather of summer and fall stimulates the use of milk in all its forms and it also causes spoilage through the greater difficulties of preservation to the average householder. There is no easy relief from this situation and only with the coming of cool weather and the consequent change of diet does the demand decrease and tend to equal the supply.

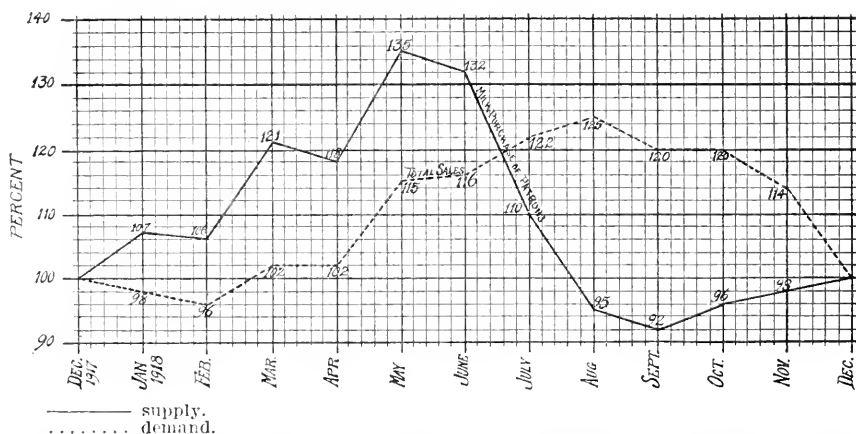
Milk production also varies immensely according to the season of the year being largest in the spring, smallest in the fall and medium in the winter. The dairyman distinguishes these three periods in order as the periods of pasture feeding, that of part pasture and that of stable

feeding, and it is easy to trace in these suggestive names the causes for the larger or smaller milk flows just noted. In addition, furthermore, to the drying up of pastures in the summer and fall seasons by which milk supply is decreased the hot weather also distresses the herd, flies and other cattle pests are at their worst and these add to the causes for a falling milk yield.

It has sometimes been urged that herd freshening at the time of annual shortage would solve the problem of a better supply of milk. Summer freshening of herds is of course possible but this does not remove the evils of hurtful weather and scant pasturage. Indeed it can easily be shown that winter dairying which requires winter or late fall freshening of herds will give the maximum of milk at lowest average costs and is, therefore, the best for the milk trade in every way.

These periodic differences between the monthly demand for milk and the monthly supply in Detroit may be easily seen by a study of the following graph where the spring surplus and fall shortage are very evident.

MILK DEMAND AND SUPPLY FOR 13 MONTHS IN DETROIT



This graph shows for the thirteen months from December, 1917 to December, 1918 the status of milk supply and demand for milk dealers in Detroit handling one-half the milk trade of the city. The month of December is taken as the typical month for the year, and the supply and demand for milk for the remaining months are reckoned in percentages above or below the amounts for this month. The solid line shows the amounts per month supplied by dairymen patrons to the companies in question. The broken line shows the amount per month sold to consumers. Late spring is the period of high supply; early fall the period of low supply. The least consumption is in mid-winter; the greatest in mid-summer and early fall.

Milk surpluses and shortages have been irritations in the milk trade from the beginning. It would seem that self-interest would encourage herds of sufficient size among dairymen to furnish dealers with an adequate supply of milk at the time of peak consumption but herds of this size are bound to give a surplus when pastures are green and rich and a greater milk flow is natural and the losses from this source tend to stop the too great growth in size of herds.

Many solutions of this milk demand and supply misfit have been offered. The fact that it is governed by natural causes makes its remedy difficult. Nearly all large city dealers have at their country receiving stations or at their city plants appliances for turning milk surplus into by-products. But this is no real solution of the difficulty since it is plain at once that high grade city milk cannot profitably be turned into milk powder, butter, cheese or condensed milk. The dairyman producer is totally without facilities for handling a surplus so that the surplus and shortage difficulty seems to be permanently a feature of the milk trade.

At any rate since it is impossible for the regular dairymen producers to furnish an adequate supply of milk in this shortage season city dealers must secure their supplies from new fields of production. This frequently requires long shipments of milk from distant places in the state which frequently must be paid for at a great loss to the city dealer.

The Commission canvassed many schemes for dealing with the surplus and shortage question. In the end the plan was adopted of distributing the misfortune of these misfits as equitably as possible between the distributors and the producers. The dealers must pay during the time of the spring months surplus full city prices for all milk used by them for ordinary city purposes. The balance of the milk, however, which the dealer must take during this time must be paid for at a rate which represents the receipts of the dealer from milk used for inferior lines of milk manufacture. There was but little complaint to the Commission over the justness of this principle and other than the practical difficulties in agreeing upon the details of the surplus it has given satisfaction to all concerned.

The correction of the shortage difficulty allowed even less room for reform on the part of the Commission than was true of the surplus. The price of milk was raised during these shortage months as high as during any other time of the year. This of course called out the greatest amount of milk possible from the dairymen since all were desirous of receiving the higher price. This together with emergency purchases from the more distant parts of the state enables the city to tide over its deficit until the coming of cold weather which once more enables the regular milk area to meet the demand.

UNIFORM MILK PRICES.

The making of uniform milk prices throughout the Detroit area was also another useful result from the commission's work. The bulletin of the Department of Agriculture, No. 639, "The Market Milk Business of Detroit in 1915" speaks on page 27 of country milk prices as follows: "The prices paid to farmers by the various dealers competing with one another in the market milk business of the city varied considerably. Milk dealers as well as the farmers were dissatisfied with conditions." The making of an official milk price by the commission ended all this. Varying only as distances from the city varied or as there were differences in the quality of milk the milk price quotation was now uniform throughout the whole area selling to Detroit.

The Commission's prices have indeed proven almost indispensable in the working scheme which is used between the Michigan Milk Producers' Association and the city dealers' organization. As is well known

annual contracts must be given by the milk dealers to the producers in order to guarantee a twelve month supply of milk for city use. But so changeable are the conditions affecting a milk price from season to season that no definite consideration of price can be made in this agreement which will be satisfactory for an entire year. On the other hand some consideration must be mentioned to make the contract binding. The plan has, therefore, been adopted of perfecting these contracts by stating the value consideration as the price which the Detroit Milk Commission shall have fixed as the proper price for the month in question. Standardized prices have come in this way to have a real meaning and usefulness in the city milk trade.

SUMMARY.

The Detroit Milk Commission plan, it may be said by way of summary, has had its success, first by accepting the task of seeing that Detroit had an adequate supply of milk. Milk under this Commission plan was a city utility the same as water, gas or electricity and the Commission identified itself as being in the same class of boards as those of schools, parks or water supplies. In brief, it took the form of an executive commission rather than one of merely administrative or judicial duties.

Second: The Commission benefited from the fact that both the country milk producers and the city milk dealers appeared as organizations thus permitting collective treatment of their wishes and grievances. Each of these organizations, indeed, monopolized its respective field of service and the city consumer of milk would have had no adequate protection as to price had it not been for the commission plan.

Third: The plan accepted cost of production as the basis from which milk prices to the consumer should be reached. These, of course, include dealers' costs as well as the dairyman's and a small profit besides was allowed. Prices like this the city consumer must expect to pay. When more universal practices among the dealers and among the producers shall have standardized their costs no more just prices can be asked for by the city consumer than those based on expenses of production.

The work of the Commission has clarified the view that milk is an indispensable city utility and it seems that an important step has been taken toward a suitable supervisory plan for the city milk supply.

APPENDIX A.

CALL FOR THE MEETING OF DETROIT MILK COMMISSION.

In consideration of the present emergency and the accompanying problems of an adequate supply of food stuffs, particularly of market milk, in which producers, distributors, and consumers are equally interested, the undersigned, in behalf of and representing the producers and distributors contributing to the market milk supply of the Detroit area, and recognizing the equal interest in the problems involved of the consumers of milk in this area, hereby request the milk commission, previously appointed by the Governor of this State to investigate the dairy industry of this state, together with one Detroit business man to be designated by the Detroit Board of Commerce, one representative of the Detroit Federation of Labor, and one woman to be appointed by the Detroit Federation of Women's Clubs, to consider the market milk problem as it relates to this area, and render judgment as to the prices at which milk should be sold by producers and distributors under present conditions, together with recommendations relating to the betterment of economic and sanitary conditions involved in the production and distribution of market milk.

MICHIGAN MILK PRODUCERS ASSOCIATION,

N. P. Hull, Pres.

R. C. Reed, Sec.

TOWERS WAYNE COUNTY CREAMERY,

W. J. Kennedy, Pres.

J. H. WILSON & SONS.

DETROIT CREAMERY CO.,

N. J. Dessert.

THE ARCTIC ICE CREAM CO.,

A. F. Stephens.

BELLE ISLE CREAMERY,

Henry Laethem.

JOHN SCHLAFF CREAMERY,

W. E. Dexter.

EAST SIDE CREAMERY,

Henry Laethem.

COTTAGE GROVE CREAMERY CO.,

A. P. Fick.

KRUEGER CREAMERY,

Frank G. Krueger.

ROSEBUD CREAMERY CO.,

Clement Philipski.

IDEAL CREAMERY,

Henry Arning.

RISDON CREAMERY,
Chas. Risdon.
Per W. L. Watson.
FRITZ CREAMERY,
Louis C. Fritz.

The above signers represent 581 milk delivery wagons out of a total of 700 wagons in the city of Detroit.

Detroit, Michigan, November 17, 1917.

APPENDIX B.

FIRST REPORT OF DETROIT MILK COMMISSION.

Acting at the request of, and under authority conferred jointly by the officers of the Michigan Milk Producers' Association and the representatives of the distributors of milk in the Detroit area, whose petition is hereto attached, the undersigned commission, so designated for the purpose, submits the following report:

Because of the importance of milk as a human food, particularly in its relation to the proper nutrition of children, this commission has approached the task to which it has been called with particular consideration to the problem of maintaining a stable supply of wholesome market milk in the great center of population represented by the Detroit area. The rapid growth of modern cities, of which the Detroit area is typical, has made this a vital and serious problem. The continued advance in the price of milk, in common with other necessities, has caused consumers whose interests are entitled to our first consideration no small concern. Yet so far as this advance may be necessary and unavoidable, we believe it to be a secondary consideration to an ample and stable milk supply, because of the absolute and universal need of this food in every family.

Instead of a normal increase of one in ten during the past two years, Michigan has suffered a decrease in dairy cows of nearly fifteen per cent, because of labor and economic conditions which have made dairying relatively unprofitable at prevailing prices for dairy products. This tendency has been further aggravated by war conditions and an unfavorable season, until the market milk supply is seriously threatened.

To insure a stable and dependable milk supply cognizance must be taken of the commercial conditions surrounding its production and distribution. These conditions, in common with those surrounding every other industry, are abnormal at the present time. The cost of feeds, which represents approximately fifty per cent of the cost of producing milk, has increased in a similar manner as has the cost of human foods. The farmer, to an even greater extent than the manufacturer, has experienced grave difficulty in securing adequate and dependable labor. The country wage has kept pace with the city wage, where men could be obtained at all, and the cost of farm and dairy equipment has increased to a corresponding degree.

The important and often unappreciated service performed by the distributors of the city milk supply has by these same conditions been rendered more difficult and expensive.

In the performance of its task this commission has sought the most dependable data relating to the cost of producing and distributing market milk and has held public hearings in the city of Detroit to receive the testimony of interested producers, distributors and consumers. This testimony included, on the part of the producers, a report of investigations in the cost of milk production in a typical market milk area contributing to the Detroit supply, submitted by the field investigator and milk accountant of the Michigan Experiment Station. This report showed that on twenty-five farms in a typical area the average cost of milk production in October was \$3.36 per cwt., or seven cents a quart. Notwithstanding this cost the dairymen continued to deliver their milk for shipment to Detroit at \$2.60 per cwt. or 5.1 cents per quart, on a previously made contract. For the month of November the cost of production was \$3.18 per cwt., or 6.6 cents per quart and the milk was sold on the same contract at \$2.60 per cwt. That the December cost will not be below that for November was clearly indicated by this report. On the part of the distributors detailed cost sheets prepared by certified public accountants were submitted and the commission was offered access to the books of distributors in the city. The data thus obtained covered separately and in detail the cost of every operation in the production, transportation, handling and distributing of the city's milk supply. Quoting from a representative cost sheet of a large distributor for the month of October, prepared by a local trust company these distribution costs, grouped under three general heads were as follows:

	Per qt. cts.
Hauling and station expense, transportation and miscellaneous	.0119
Receiving, pasteurization, bottling, bottles and caps, power and refrigeration and shrinkage.....	.0151
Selling and delivery, cold room and administrative expense..	.0354
Total .....	.0624

In submitting verified costs, both producers and distributors expressed a willingness to follow the plan laid down by, and cooperate with the expressed wishes of, the United States Food Administration in having the remuneration for their product and service fixed at actual cost plus a very modest profit. Believing that the interests of the consumers would be best served, and the welfare of all best promoted by the application of this just principle, this commission has given it special emphasis in its price considerations.

Since an adequate milk supply at all seasons is indispensable to the welfare of a city, it is necessary for this commission to arrange such schedules of prices as will insure a proper safe-guarding of the market milk areas and prevent the necessary city supplies from being diverted into condensed milk and other similar products. Fortunately, this task is simplified by the fact that the cost of production as shown by the data before this commission closely approximates the prices prevailing for milk purchased for condensing purposes in the same areas.

The testimony taken reveals the fact that certain undesirable practices have become common in the collection and distribution of milk which

have resulted in waste, and which, in the opinion of this commission, ought to be eliminated, or at least materially reduced. Excess costs in the distribution of milk must be borne by the producer or consumer, or by both as the case may be. Where such excess costs can be eliminated by either producer or consumer, a desirable economic gain will result. By custom containers for both the shipment and the distribution of milk are furnished by the distributor, without specific service charge. This practice has led to gross carelessness on the part of many, and in some instances to absolute dishonesty. Carelessness in returning, and the misappropriation of milk bottles results in a large aggregate loss which in this period of high-priced glass occasions a very appreciable increase in the cost of distributing milk. In view of this waste this commission recommends that the distributors adopt some feasible system of charging bottles to consumers or dealers, while in their possession and crediting them with same on their return.

In view of the unavoidable advance in the retail price of milk delivered to patrons in the Detroit area to meet the present emergency, this commission believes that some provision should be made for the selling of milk at a lower price where the consumer buys it at a distributing station, thus reducing the cost of the service rendered by the distributor. The testimony showed the cost of delivery to be approximately three cents per quart. We therefore find that milk shall be sold at selling stations to be established or designated by the distributors at three cents per quart below the delivered price, with a charge of five cents per bottle to be refunded on its return. We ask the distributors to co-operate in making a thorough trial of this plan at once and to prepare detailed information as to the result of the trial for review by the Commission at a future meeting.

To relieve special cases where unfortunate citizens are unable to purchase milk imperatively needed in sickness or for children the distributors have offered to supply it gratis upon application to and approval of either the Board of Health or the Poor Commission.

In the collection of milk at some shipping points, it has become a frequent practice to make various allowances to the carrier in addition to the usual hauling charge to the patron, thereby increasing the service cost of the supply rather than the compensation of the producer. This practice should be discontinued so far as possible, with the maintenance of an adequate milk supply, and the price fixed for the producers' milk applies to the milk delivered at the shipping station platform.

Having been petitioned as above noted to render judgment as to the prices at which milk should be sold by producers and distributors in the Detroit area under present conditions, this commission believes that in view of the uncertainty of the continuance of present conditions, particularly as they may relate to the cost of feeds used in the production of milk, the prices hereinafter fixed for the period beginning December 1, 1917, should be made subject to review by this commission on its own initiative or on petition of producers, distributors or consumers, and to readjustment for future months if, in the judgment of the commission, such readjustment is essential to the preservation of justice and equity as between the parties or classes concerned. To this end the commission accedes to the request of the producers and distributors to continue to act in the above capacity for a period of one year from date.

Milk is one of the very cheapest available human foods. We believe that the mutual interests of consumers, producers and distributors will be conserved by the giving of greater publicity to this fact. We hereby commend the action of the milk producers at their recent meeting in advocating the appropriation of one-half cent per hundred pounds on all market milk sold in the Detroit area for the creation of a fund to be used in such publicity work or otherwise for the promotion of the dairy industry in this area, and recommend that all contracts made for market milk in this area should provide for the deduction of such a sum from each patron's check and the payment of same into the treasury of the Michigan Milk Producers' Association by the receiving distributor.

In consideration of the above mentioned facts this commission finds that the contract price for market milk in the Detroit area beginning December 1, 1917 to producers in the fifteen cent freight zone, shall be \$3.35 per hundred pounds, f. o. b. shipping station platform, for milk testing 3.5 per cent of butter fat, with a deduction of four cents per point for milk below this standard of butter-fat and with an addition of four cents per point for every point above this standard up to and including 4.2 per cent milk.

We further find that milk be sold by distributors in the Detroit area at the following prices:

Retail quarts, delivered, 14 cents.

Retail pints, delivered, 8 cents.

Wholesale quarts, delivered, 13 cents.

Wholesale pints, delivered, 7 cents.

Bulk, gallon, delivered, 44 cents.

Retail at selling stations per quart, 11 cents, with a five cent charge for bottle to be refunded on its return.

December 1st, 1917.

SOY BEANS.

Special Bulletin No. 100

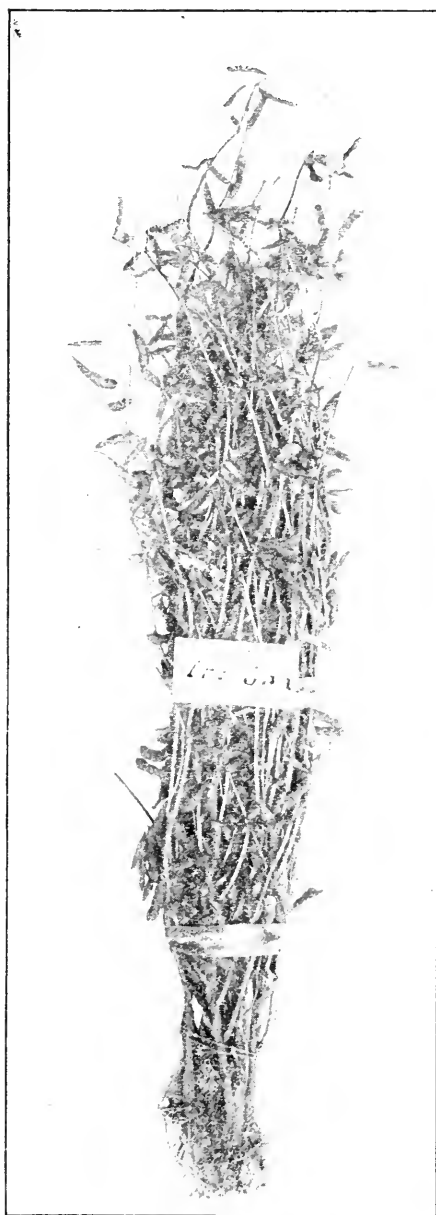
C. R. MEGEE, FARM CROPS SECTION.

Interest in soy beans has increased greatly in Michigan during the past two years due to the following reasons: First, frequent failure of clover has made it necessary to secure an emergency hay crop which will furnish hay the same season as planted; second, increase in favor of the practice of sowing soy beans with corn for ensilage and hogging-off; third, increased demand for northern grown soy bean seed throughout Michigan and bordering states; fourth, greater use of soy beans as a green manuring crop.

Since this crop is a comparatively new one, its value in Michigan agriculture will depend very largely on its proper use which makes necessary accurate knowledge of the nature of the plant, the time, rate and method of sowing, inoculation, varieties, method of harvesting and feeding value.

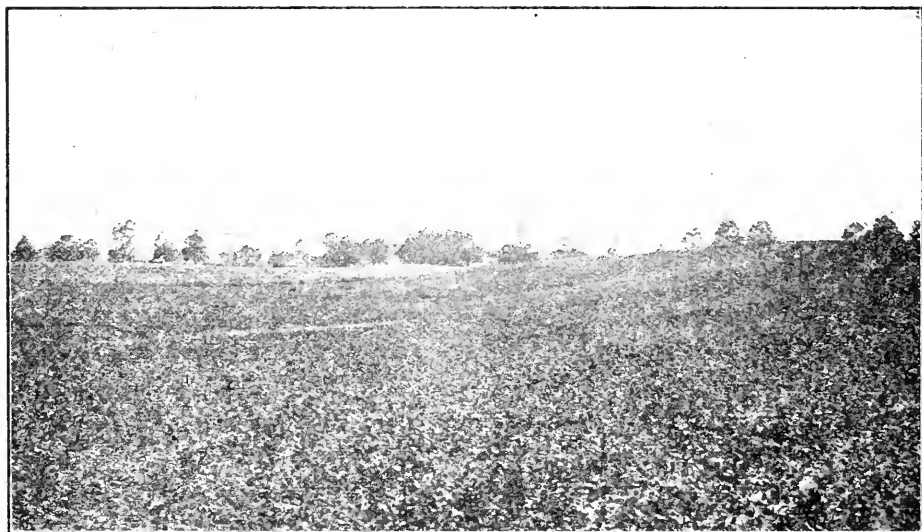
The soy bean is an annual plant, in that it grows and matures the same season under favorable conditions. It is a legume and when inoculated takes free nitrogen from the air and stores it in its tissues and in the soil, thereby making the crop a valuable one for improving soils deficient in nitrogen and organic matter. This fact makes it a better crop to substitute on ground where clover has failed, than some of the non-leguminous crops such as millet and sudan grass which often leaves the land in poor condition for a following crop. Chemical analyses show that soy bean hay is higher in protein than clover hay, and that when properly cured it makes a valuable substitute. Of recent years failures with clover seedings have been frequent, due to the lack of lime, organic matter and available plant food. When possible it is a better farm practice to correct the deficiency in the soil by the application of ground limestone or marl, barnyard manure and acid phosphate and make possible good crops of clover and alfalfa, rather than to depend upon substitute hay crops. However if clover or alfalfa hay is lacking, adapted varieties of soy beans offer an excellent substitute and quick returns.

While soy beans apparently are of greatest value in this State as an emergency hay crop, they are used in a number of other ways. When a late spring or early summer-sown leguminous green manuring crop is desired, the soy bean is preferable because of its comparatively high yield per acre. When corn is to be hogged-off, a practice increasing in favor in lower Michigan counties, soy beans may be planted at the same time as the corn, thereby supplying more feed of a greater variety and higher protein content than corn alone. Only varieties that will produce well-filled pods should be used for this purpose. Soy beans are frequently planted with corn for ensilage, a practice which is increasing in favor in Southern and Central Michigan.



Soybean plant showing pods.

The increased acreage of soy beans planted for hay, ensilage and green manuring has created a heavy demand for seed of the better varieties. Yields of from 12 to 16 bushels per acre are usually secured while yields as high as 25 to 30 bushels per acre have been reported. The soy bean is not seriously affected by blight, rust, and anthracnose, which frequently damage common field beans quite seriously. Owing to its high percentage of fat and protein, soy bean seed is sometimes fed as a concentrate. The seed ranks with cotton seed meal and oil meal in fat and protein content.



Soy beans are a valuable green manuring crop. The view above shows soybeans drilled on an impoverished sandy loam soil.

VARIETIES.

The selection of the variety is of great importance as shown by tests conducted during the past six years, some varieties yielding from three to four times as much forage as others.

The following varieties are considered among the best for Michigan conditions:

Manchu,
Ito San,
Early Brown,
Black Eyebrow.

The Mammoth Yellow and Ogemaw are quite inferior for forage purposes. The Ogemaw matures very early and produces but little plant growth comparatively, while the Mammoth is quite late in maturing, and consequently, not adapted to this state.

In northern Michigan counties, the Early Black is apparently the best adapted variety.

The following table gives the yields in pounds per acre of air-dry hay

produced in 1919, a favorable year, by each variety, together with notes on maturity. In 1917, a very unfavorable year, few soy beans matured in this state.

SOY BEAN VARIETY TEST--1919.

Planted June 8th, harvested September 4th.

Results corrected according to checks in pounds per acre on 12% moisture basis.

Variety.	Pounds per acre. Air Dry Hay.	Maturity.
Manchu.....	5107	Pods forming.
Ito San.....	4931	Seeds well formed.
Early Brown.....	4760	Seeds well formed.
Black Eyebrow.....	4688	Seeds well formed.
Medium Green.....	4370	Seeds just forming.
Mongol.....	4351	Seed just forming.
Virginia.....	4212	Pods just forming.
Wilson 5.....	4193	Pods just forming.
Hollybrook.....	4065	Pods forming.
Wisconsin Black.....	3698	Seed nearly mature.
Wilson.....	3475	Just past bloom.
Michigan Favorite Cow Pea.....	2108	No pods.
Ogemaw.....	1561	Mature.
Mammoth Yellow.....	1276	No pods.

During the past season (1919) five variety tests* were conducted in four different counties. The results of these tests correspond very closely with results at the Station. In each test one of the following varieties: the Ito San, Black Eyebrow, or Early Brown, ranked first. The Manchu was not included. In each test the Mammoth Yellow ranked last. The following table gives the yields in tons per acre of air-dry hay produced by each variety:

County.	Ito San.	Black Eye- brow.	Med. Green.	Mammoth Yellow.	Ely. Black.	Wilson.	Hollybrook.	Mongol.	Ely. Brown.
Allegan.....	.86	1.10	.50	.18	.31	.56	.57	.41	.72
Bay.....	3.26	3.57	2.55	1.12	2.91	2.90	2.56	3.27	2.27
Monroe.....	3.42	2.55	2.74	.68	2.43	1.86	3.16	2.94	2.66
Monroe.....	1.68	1.44	1.26	Failure	1.71	1.65	1.62	1.73	1.81
Wayne.....	1.37	1.35	1.18	.45	.90	.98	1.07	1.28	1.41

ADAPTATION.

Soy beans will grow on all types of well-drained soils of sufficiently long season such as are adapted to the production of corn for grain. They do best on soil well supplied with lime, but will make considerable growth on soils that are somewhat acid which makes them adapted to sandy soils. In case the soil is very acid a large growth should not be expected. Soy beans frequently make considerable growth on light, sandy soils that are so deficient in organic matter that alfalfa and red or June clover do not catch.

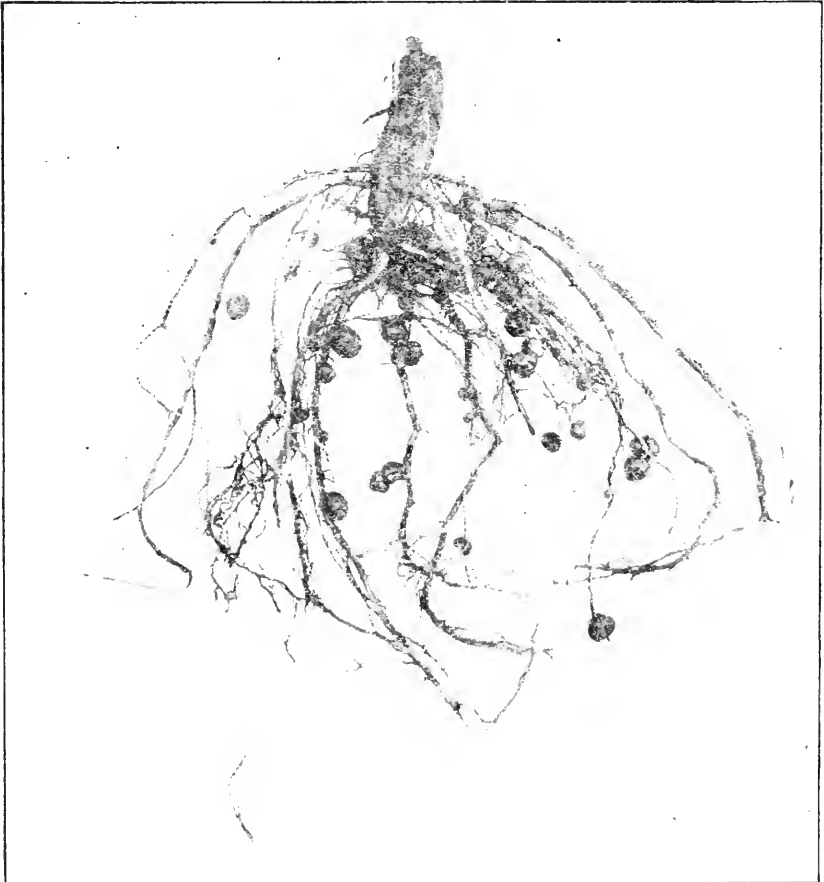
*Sectional variety tests conducted by Prof. J. F. Cox, E. K. Chamberlin, and C. R. Megee.

PREPARATION OF SEED BED.

The seed bed for soy beans should be prepared in the same manner as for corn or other cultivated crops. If not plowed in the fall, the ground should be plowed as early in the spring as possible and harrowed at frequent intervals until planting time. On light sandy soils or extremely heavy soils spring plowing is preferable, while both fall and spring plowing is satisfactory on well-drained clay loams, loams, and sandy loam soils. If the field is foul with weeds fall plowing followed by early spring cultivation is advisable especially if the soy beans are to be sown in drill rows seven inches apart and not cultivated.

TIME OF PLANTING.

As a rule the best time to plant soy beans is immediately after corn-planting time. From May 20 to June 15 is usually satisfactory for either hay or seed. For green manuring, plantings as late as July 1st can be



Soybean root system showing nodules.

made, though earlier planting is advisable. Mr. E. E. Evans, legume specialist of West Branch, Ogemaw Co., Michigan, states that the greatest error of soy bean growers in northern Michigan is too late planting and that he has never seen the crop seriously injured by frost between May 10th and October 1st. The past season (1919) Ito San soy beans planted at the Experiment Station on May 21st yielded 624 pounds per acre more hay than did the same variety planted June 7th. In southern and central Michigan and on the earlier soils of Northern Michigan it is good practice to have the soy beans planted by early June.



A Field of Soybeans.

DEPTH OF PLANTING.

It is advisable to plant as shallow as possible and still cover properly. Since it is difficult for soy beans to get above ground too deep planting will result in a very poor stand. When the seed is poorly covered on the loamy and lighter soils, a thorough rolling will usually cover all uncovered beans. If the ground is very dry deeper planting will do no harm unless a beating rain should form a crust. In case a crust is formed before the beans have made signs of appearance above the ground, a very light harrowing with a spike-tooth harrow will be beneficial.

INOCULATION.

When planting soy beans in a field for the first time, it is desirable to inoculate if the best results are to be secured that season. There are several methods of inoculation, one of the simplest being by the pure culture method. This material may be secured from the Department of Bacteriology, M. A. C., East Lansing, Mich. Full directions for application accompany the material.

Another method is to take well-inoculated soil from a field where soy

beans were grown successfully with an abundance of nodules on the roots the season previous. This soil may be applied through the fertilizer attachment or sown broadcast over the field and harrowed in. Three hundred pounds of soil is sufficient to inoculate one acre. The soil should be protected from the sun at all times, since bright sunlight injures the bacteria. The soil method of inoculation has been very successful. The glue method may be used when it is not convenient to secure large quantities of soil. From one to one and one-half ounce of carpenters' glue is dissolved in a quart of water and sprinkled over a bushel of seed, which has been spread out on the barn floor. The seed is shoveled over so that the glue solution will come in contact with each seed. About a quart of fine soil that has been secured from a soy bean field where the roots had an abundance of nodules is sprinkled over the seed. The soil should be screened to remove stones and clods. The glue method has also been successful, the pure culture method is being used largely, however, due to the ease of securing the culture and simplicity of application.

METHOD OF PLANTING.

The method of planting soy beans will depend largely upon the use which is to be made of the crop.

For hay and green manure. Soy beans may be planted in rows 28 inches apart, with an ordinary grain drill, by leaving open the second, sixth and tenth hole. When planted in this manner, the soy beans should receive an occasional cultivation.

If the land is free from weeds and there is sufficient moisture to carry the crop, larger yields and a finer quality of hay can be secured by planting with the ordinary grain drill all holes open and drill rows seven inches apart. On the Experiment Station Farm, East Lansing, the past season, 799 pounds more hay per acre was secured by the latter method. No cultivation is necessary when planted in this manner, which is an important factor when labor is scarce.

For ensilage and hogging-off. When soy beans are to be sown with corn for ensilage or hogging-off a special soy bean attachment should be secured for the corn-planter. This attachment consists of a separate drill and grain-box, so that it is not necessary to mix the corn and soy beans. The practice of mixing the corn and soy beans and drilling from the same grain box is not very satisfactory because the soy beans are round and smooth and soon work to the bottom of the box and an even stand of corn and soy beans is not secured. When only a small acreage is to be planted this may be overcome quite largely by putting in a small quantity of seed and mixing frequently. Experiments indicate that the yield of corn may be decreased from 3 to 5 bushels when planted together.

Soy beans sown at the last cultivation of corn seldom make a satisfactory growth. Some farmers prefer to sow the corn and soy beans separately and mix the two as they are put in the silo. When this method is followed the soy beans are sown the same as for hay.

For seed. The heaviest yield of soy bean seed is secured by drilling in rows from 28 to 32 inches apart, using an ordinary grain drill with every fourth cup open or planting with corn or bean drill.

Amount of seed required. When soy beans are planted in rows 28 inches apart it will require from two to three pecks of seed per acre,

two pecks of the smaller-sized seed being sufficient, while three pecks are necessary of the larger seeded varieties.

When sown with a grain drill and all cups are open, it will require from five to seven pecks of seed for one acre. When broad-casted, at least two bushels of seed should be used. This practice is not economical on account of the excessive amount of seed required. When planted with corn for ensilage four or five quarts of soy bean seed per acre together with the usual amount of corn is sufficient. Larger amounts of soy beans may decrease materially the yield of corn.

LIME.

Soy beans are not as sensitive to an acid or sour soil as alfalfa, sweet clover or red clover. This fact makes the soy beans a useful crop on the light soils. These soils are usually deficient in organic matter and nitrogen, and the growth of a legume makes it possible to secure larger yields of other crops. Consequently, when it is not practical to lime, soy beans may be used. When the soil is very deficient in lime an application of two tons of ground limestone or several cubic yards of marl per acre usually gives an increased yield of soy beans and makes possible the growth of other leguminous crops.

PHOSPHATE.

Soy beans can be expected to give the same return from the use of acid phosphate or a fertilizer high in phosphorus as field beans. An early and more evenly maturing crop and heavier yielding crop will result from proper fertilization. An application of from 200 to 250 pounds of acid phosphate or mixed fertilizer high in phosphorus is recommended. This application should be made at time of planting, through the fertilizer attachment on the drill or applied broad-cast in fitting the seed bed. The latter method is advised when soy beans are planted in rows and cultivated.

HARVESTING.

When grown for hay, soy beans should be harvested between pod formation and full development of the seed, and before the leaves have turned yellow and dropped off. If cut earlier than this, the yield of hay will be reduced and much more difficult to cure and if cut later, the stems become quite woody, the leaves drop off and the quality of the hay secured is much inferior.

Soy bean hay is cured in much the same way as a heavy crop of clover or alfalfa hay. It should be cut when the dew is off, and if the weather is favorable, raked into windrows the next day, and the third day put into small cocks where it is allowed to stand until well cured out and safe to store.

Seed. When desired for seed, harvesting should begin when a majority of the pods have reached maturity. Either the mowing machine or grain binder may be used. The soy beans should preferably be handled during the early morning while the dew is on to prevent shattering. The use of the bean harvester has not generally given satisfaction, but if blades are left very sharp it may be used with good results. When cut

with the mower, the plants are gathered into windrows and then into small cocks and allowed to cure. The use of the grain binder is very satisfactory, the soy bean plants being formed into small bundles and placed in open shocks. When cured, the beans may be threshed direct from the shocks or put into stacks. They may be threshed through a bean separator or through an ordinary grain separator, with the cylinder running at half-speed, and the other mechanism running at the usual speed. Small amounts can readily be beaten out with a flail.

SUMMARY.

Soy beans are grown for hay, with corn for ensilage and hogging-off, for green manuring, as a protein concentrate, and a seed crop.

Soy beans are adapted to all types of well-drained soils in sections where the growing season is suited to the production of corn for grain.

Soy beans frequently make considerable growth on light, sandy soils that are so deficient in organic matter that alfalfa and red or June clover fail.

When planting soy beans in a field for the first time it is desirable to inoculate.

Selection of variety is very important, the Manchui, Ito San, Early Brown, and Black Eyebrow being high yielders of grain and forage.

Soy beans should be sown just after corn-planting time, from May 15th to June 15th.

Soy beans should be planted shallow. For hay or as a green manuring crop, either plant in rows 28 inches apart, using about 40 pounds of seed per acre or in rows 7 inches apart, with grain drill, using from six to eight pecks of seed per acre. For seed, plant in rows 28 inches apart, using from 30 to 40 pounds of seed per acre.

When planted with corn for ensilage better results are secured by using a soy bean planting attachment on the corn planter.

For hay, cut when the pods are well-formed and beginning to fill and before the lower leaves turn yellow and drop off.

For seed, allow pods to reach maturity, harvesting before shattering stage is reached.

Cowpeas are not as well adapted to Michigan conditions as soy beans.

OATS IN MICHIGAN

Special Bulletin No. 101

J. F. COX, FARM CROPS SECTION.

The climate of Michigan is extremely favorable to oat production, the average Michigan season providing ample rainfall and a sufficiently long growing season, usually free from extremely hot or dry periods, for the maturity of the highest yielding and heaviest varieties. Michigan also offers extensive areas of loams and clay loams, high in fertility and retentive of moisture, which are splendidly adapted to oats. The acreage planted to oats has undergone a marked increase during the past 20 years, due largely to the strong demand for oats and the increased acreage of corn, beans, beets and potatoes—cultivated crops which are harvested in the fall too late during the majority of seasons for adequate preparation of the land and safe planting to wheat. Oats are well suited to Michigan rotations including these cultivated crops, since the land is usually in excellent condition for fitting for oats, and because of the fact that Red Clover, Alsike, Timothy, Alfalfa, and Sweet Clover, etc., if rightly handled, can be seeded with reasonable safety with oats.

At the present time oats are second to corn in acreage. During 1918 the area occupied by oats was 1,658,000 acres and the production 66,320,000 bushels, or an average yield of 40 bushels per acre. In 1919, an extremely unfavorable year, the acreage harvested was 1,475,000 and the production 36,875,000 bushels, with an average yield of 25 bushels per acre. The average yield for the past 15 years, 1905 to 1919 inclusive, is 32.1 bushels from an average acreage of 1,459,472.

Michigan's leading counties in oat production are those in the southeastern quarter of the state, ranging north through the "Thumb" area. A close study of oat production in Michigan brings out the fact that certain farmers produce dependably much larger yields under similar soil and climatic conditions than a majority of their neighbors. The facts conveyed in this bulletin are based on observation of the methods employed by these most successful oat growers, and experiments performed by the Michigan Experiment Station.

It is strikingly apparent that tremendous possibilities are offered for increasing the profit from oats under existing marketing conditions, and placing the crop on a much more dependable basis by the more wide-spread employment of the practices of the best oat growers, such as the planting of high yielding varieties, applications of Acid Phosphate, the treatment of seed with Formaldehyde, and the better preparation of the seed bed.

OATS PRODUCTION IN MICHIGAN 1905 TO 1919.

(From Mich. Crop Report Jan. 1, 1920.)

YEAR.	Aeres harvested.	Average yield per acre.	Total production, (000 omitted).	Average price December 1.	Total value, (000 omitted).	Average value per acre.
	Aeres.	Bushels.	Bushels.	Dollars.	Dollars.	Dollars.
1905.....	1,010,000	35 6	35,949	0.30	10,785	10.68
1906.....	1,425,900	39 7	43,748	0.33	14,437	10.13
1907.....	1,468,000	29 8	30,534	0.48	14,656	9.98
1908.....	1,409,000	29 7	41,847	0.49	20,505	14.55
1909.....	1,429,076	39 7	43,870	0.41	17,986	12.59
1910.....	1,515,000	34 0	51,510	0.35	18,028	11.90
1911.....	1,500,000	28 6	42,900	0.46	19,734	13.16
1912.....	1,485,000	34 9	51,826	0.33	17,103	11.52
1913.....	1,500,000	30 0	45,000	0.29	17,550	11.70
1914.....	1,515,600	33 5	50,752	0.45	22,838	15.08
1915.....	1,530,000	42 0	64,260	0.35	22,491	14.70
1916.....	1,423,000	30 0	42,690	0.53	22,626	15.90
1917.....	1,550,000	36 0	55,800	0.64	35,712	23.04
1918.....	1,655,000	40 0	66,320	0.69	45,761	27.60
1919.....	1,475,000	25 0	36,875	0.71	26,181	17.75
Average.....	1,459,472	32 1	46,925	0.46	21,700	14 69

SOILS FOR OATS.

Oats thrive best on fertile loams and clay loams sufficiently charged with organic matter to carry moisture throughout the season. Light loams and sandy soils are inclined to be too droughty for high production. On muck soils and soils very high in organic matter, oats frequently lodge badly and fail to fill properly. Heavy clay lands can be put in condition for dependable oat production by tile draining.

PREPARATION OF SEED BED.

Oats are generally planted after such cultivated crops as corn, beans, beets and potatoes. The land following these crops is as a rule comparatively free of weeds and in most instances can be fitted for oats by a thorough discing early in the spring. The earliest possible discing is recommended. Oats start best on a firm, well settled seed bed with the surface worked into a condition of good tilth. Clean land following cultivated crops can usually be put in this condition by thorough discing.

If the land is weedy or of a nature not readily worked into a condition of good tilth, fall plowing or early spring plowing to a medium depth is recommended. Fall plowing is particularly advisable under such conditions, since it gives time for the soil to settle thoroughly. If plowed in the spring the ground should be thoroughly compacted immediately after plowing with the roller and fitted with disc or spring tooth harrow or with cultipacker. Fall-plowed land should be disced as early as possible in the spring.

VARIETIES OF OATS.

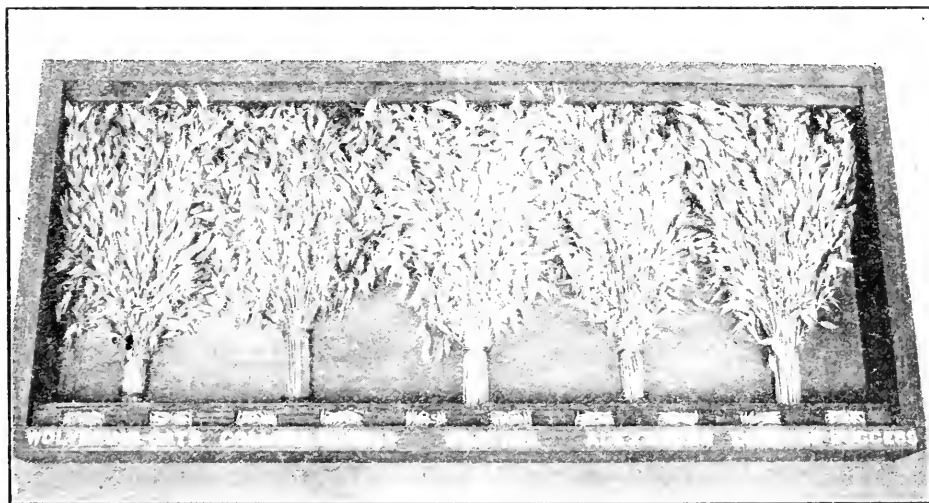
Numerous variety tests, conducted by the Michigan Experiment Station at East Lansing, and in fourteen well distributed Michigan counties, have demonstrated the fact that there is a wide difference in yield, and a difference in adaptation, of oat varieties. These tests show the

marked superiority of pure strains, or pedigreed oats over the average run of varieties.

During the past two years these improved strains have gained greatly in acreage, but as yet a large percentage of Michigan's oat acreage is planted to mediocre, poor, or unadapted varieties. Frequently the improved strains in variety tests will out-yield varieties gathered up in the neighborhood of the tests and planted and harvested under the same conditions by as much as 20%. It is safe to say that the great majority of oat growers in Michigan, who as yet grow unimproved varieties, can better their yields by several bushels per acre by adopting a high yielding variety, without extra cost of production, except the slight increase in work resulting from harvesting a heavier crop, and the small initial extra cost of changing seed.

For the past 15 years, F. A. Spragg, Plant Breeder of the Michigan Agricultural College, has devoted much time to the production of improved oat varieties. The method which he follows, briefly stated, entails the careful selection of pure strains from the highest yielding varieties as determined by test, and the increase of these pure strains on the Experiment Station increase plats, for wide-spread distribution to Michigan farmers through the agency, largely, of the Michigan Crop Improvement Association. These improved or pedigreed varieties have demonstrated their worth in the field and can be secured in quantity from members of the Michigan Crop Improvement Association, and from many Michigan seed companies, as well as from farmers growing them in practically all Michigan oat growing counties.

The following pedigreed varieties, developed at the Michigan Agricultural College, have proven their excellence: Wolverine, College Wonder, Worthy, College Success, Alexander.



HIGH-YIELDING, PURE-STRAIN VARIETIES.

The Wolverine, College Wonder, College Success, Worthy, and Alexander are pure strains of oat varieties, originating at the Michigan Agricultural College and extensively distributed by the Crop Improvement Association and leading Michigan seed companies. These varieties are open panicked white oats and yield consistently better than the great majority of ordinary oat varieties.

Varieties from other sources, which are often in the high-yielding class, are the following: Swedish Select, New Victory, Silver Mine, White Bonanza, Strube, Johnson, Big Four, Swedish Crown.

The Wolverine, College Wonder and Worthy, all open panicle white oats, may be selected as leading varieties under the widest range of conditions. The Worthy has been well known for the past 10 years and has proven particularly successful on heavy lands where ordinary oats tend to lodge. The stiff straw and vigorous stooling capacity of this variety undoubtedly gives it considerable advantage under these conditions. The Wolverine and College Wonder, more recently introduced, have surpassed the Worthy in yield in a majority of instances and seem to possess equally stiff straw and vigorous habits of growth. These varieties consistently out-yield side-oats and black oats.

Full details regarding characteristics of varieties and methods of developing improved strains may be found in reprint, "Oat Varieties for Michigan," by F. A. Spragg from the annual report of the Michigan State Board of Agriculture for 1919.

FERTILIZERS FOR OATS.

Acid Phosphate, or fertilizers high in Phosphorus, almost universally give a marked increase when applied to land fitted for oats in Michigan. Not only is the yield and weight per bushel increased, but the crop matures more uniformly and at an earlier date, and the tendency to lodge on heavy soils is overcome to a considerable extent.

Apparently the most profitable application ranges from 200 to 300 lbs. of Acid Phosphate per acre, applied at the time of planting, through fertilizer attachment on drill, or broadcast when fitting the seed bed. Finely ground Rock Phosphate or "floats" used at the rate of from one-half ton to one ton per acre is also profitable.

On certain soils, particularly those low in organic matter, Ammoniated Phosphate carrying Nitrogen and Phosphorus, or a complete fertilizer carrying Nitrogen and Potash, in addition to Phosphorus, may be advisable at rates of from 150 to 250 pounds.

Muck soils are usually markedly benefited by applications of a fertilizer carrying both Potash and Phosphorus.

The great majority of Michigan oat soils will respond best to applications of Acid Phosphate. The attention of Michigan oat growers is directed with particular emphasis to this profitable practice. Bulletin No. 281, by Professor M. M. McCool and associates of the Soils Section, Michigan Agricultural College Experiment Station, gives the results of numerous field experiments with the use of Phosphorus on oats and other small grains.

BARNYARD MANURE.

Oats in common with other crops respond to the use of manure properly applied. It is customary to make heavy applications of manure where available, previous to fitting the land for corn or other cultivated crops preceding oats. The oat crop is benefited through the residual effect. On soils lacking in organic matter direct applications before preparing the land for oats, or when fitting the seed bed, will be found effective.

On fertile lands the application of manure to oats is as a rule not advisable as it may cause too vigorous a vegetative growth, and oats will tend to lodge when nearing maturity. The best practice is to apply the manure before the cultivated crops in the rotation. The use of Acid Phosphate in connection with manure will greatly increase its value.



Variety test of oats, Michigan Agricultural College.

LIME.

The use of ground limestone, marl, or other forms of lime, is effective in increasing the yield of oats and of clovers, or alfalfa seeded with oats. For continuous success with oats or other grain crops, a vigorous growth of leguminous crops in the rotation is necessary. The use of lime on soils needing it is strongly recommended.

Lime should be applied in the rotation, preferably when fitting the seed bed for a cultivated crop, or if not applied at that time, when seeding for oats.

Bulletin No. 91, giving detailed information regarding lime, can be had from the Michigan Agricultural College. Most Michigan soils, particularly those which have been farmed more than a generation, need lime for a successful clover crop. Lime may be applied in the form of ground limestone, marl or as hydrated or "agricultural" lime. Usually two tons of ground limestone per acre, or from six to eight loads of marl, or 1,000 to 1,500 pounds of hydrated lime per acre, if that form is used, will pave the way for a good clover crop and for better yields of succeeding grain and cultivated crops. The land should be limed previous to seeding clover, preferably the year before. Oats will yield better on a well limed soil than on an acid one.

PLANTING OATS.

Oats should be planted as early in the spring as the ground can be put in good condition. As a general rule April or early May plantings give much better results than plantings made towards the middle of May. Planting as late as the middle of May or after usually results in a much lessened stand. Oats make their best growth before the heat of summer; hence, they should be given as early a start as is possible by planting as soon as the ground is warmed up.

The usual rate of planting is 8 pecks per acre. When planting is somewhat late, 10 pecks give better results, since stooling is not so vigorous. On very heavy clays or soils very high in organic matter, such as muck lands, planting at the rate of 3 bushels or more has been shown to give higher yields.

CLEANING AND GRADING SEED.

A good fanning mill cleans out light oats, pin oats, chaff, weed seeds, and dirt. Its use will usually add several bushels to the acre yield—enough to pay for its cost in a short time. In the case of oats, more than other grains, large plump seed shows an increase in production.

SEED TREATMENT TO PREVENT SMUT.

A great loss is caused each year in Michigan by the loose smuts of oats. It has been demonstrated that this loss can be controlled successfully by the formaldehyde treatment. This treatment consists in sprinkling seed oats thoroughly with a solution made in the proportion of one pound (or one pint) of formaldehyde to forty gallons of water.

The formaldehyde used should be of forty per cent strength and must be fresh. When it is considered that very frequently oat smut causes the loss of ten bushels or more per acre where the seed is not treated, and that the cost of purchasing enough formaldehyde to treat one hundred bushels or more of seed oats hardly exceeds \$1, it is apparent that this treatment is a very cheap form of insuring the oat crop against such loss. All oats planted in Michigan under present conditions should be treated with formaldehyde.

Dr. G. H. Coons of the Botany Department, Michigan Agricultural College, East Lansing, recommends the following in Extension Bulletin No. 13:

OLD SPRINKLING METHOD.

Mix one pint of fresh formaldehyde with 40 gallons of water. Clean a place on the barn floor and sprinkle with this solution. Spread the oats in a thin layer (four inches) and sprinkle with the dilute solution of the formaldehyde. Shovel over and over until every kernel is moist. Add layer after layer, sprinkling as before. Two quarts of solution is enough to allow to a bushel. When all the grain is moistened, shovel into a compact heap, cover two hours with a blanket or canvas, then spread out to dry and air. Do not let the wet grain freeze, mould or sprout.

The grain may be planted as soon as it is dry enough to run through the drill. Make allowance for the slightly swollen condition when

planting. One pint of formaldehyde will treat from 50 to 60 bushels.

The treatment may be modified by dipping the grain, one-half to one bushel at a time, in a barrel or tub of the dilute solution. Drain, cover for two hours, dry and the oats are ready for planting.

THE NEW CONCENTRATED FORMALDEHYDE TREATMENT.

Use formaldehyde at the rate of one pint to 50 bushels of grain. For smaller amounts of grain use correspondingly smaller amounts of formaldehyde. It is unnecessary and unsafe to use more formaldehyde than the amount recommended. Put the right amount of fresh formaldehyde just as it comes from the druggist, into a pint or quart hand sprayer or atomizer and spray the grain as it is shoveled over and over. The formaldehyde may be diluted two or three times to secure better distribution. If the sprayer is kept close to the grain and if the treatment is given in a room where there is a good draft, the penetrating odor of the formaldehyde will give no discomfort.

When the right amount of formaldehyde has been applied, shovel the oats into a heap and cover for exactly four hours with a canvas or blanket.

The grain should then be spread out thinly for a thorough airing in a warm place. Rake the grain over during this airing, then plant at once.



The formaldehyde treatment is cheap and easy. It is an effective insurance against smut injury.

THE GERMINATION TEST.

After unfavorable seasons, the germination of oats may be poor. This means that many who plant at the usual rate will not secure the usual stand. The per cent of germination is very easily ascertained. A reliable germination test can be made by placing one hundred oat kernels on a wet blotter or cloth between pie pans, placing where the temperature is favorable for sprouting. After four or five days the oats which have sprouted may be counted and the per cent of germinable oats readily figured. An increased rate of planting to offset dead or weak sprouting seeds is advised if germination is less than 95%, or, if very poor, other oats should be secured for seed. The same testers used in the germination test for corn may be used for oats.

HARVESTING OATS.

Oats should be harvested when in the dough stage, since at that time they give a maximum yield and the greatest weight per bushel. When allowed to get too ripe there is likely to be a loss from shattering. Oats cut in the dough stage make better feed and have a better color. The market demands clean, white, oats of good color and sweet odor. The legal weight per bushel is 32 pounds in Michigan, though oats of superior quality, weighing 36 pounds or more per bushel, are frequently met with.

To insure oats of good market quality careful handling is necessary. It is usual to set sheaves in long shocks, two by two. These are later gathered into round shocks and capped with two bundles as wheat is capped. Stacking in large stacks or in barns, provided the stacking is properly done, usually insures better color and a higher quality of oats.

OATS IN ROTATION.

It is necessary to grow oats in rotation with other crops to insure profitable production. Oats fit well in Michigan rotations, usually following corn, potatoes or beans. In average seasons and on moisture holding soils, clover or clover and timothy seeded with oats is usually successful. The usual clover seeding is 8 to 10 pounds of red clover per acre, or 4 pounds of red clover and two pounds of alsike per acre. Where mixed timothy and clover is desired, from 2 to 6 pounds of timothy is added to the clover seeding.

Since the rotation of crops is largely depended on to keep up the organic content of the soil and provide nitrogen, a good clover crop benefits the oats as well as other crops grown in the rotation.

STATE LAWS GOVERNING THE PROTECTION AND PLANTING OF STREET TREES.

Circular No. 41

The State, recognizing the value of street trees, has passed laws to promote street and roadside planting and to protect trees already growing along the public highways. While more encouragement should be given to the planting of permanent trees, both in city streets and along country highways, the preservation of existing trees presents a more immediate and serious problem. Aside from the damage and loss of trees, due to fungus and insect enemies, gas, smoke and poor soil conditions, they have to contend against the inroads of telephone linemen, electric light wires, trolley companies, gas mains, and such public utility companies as often use the highways for their private profit with little regard for the public rights in tree property.

Property owners should be informed of these laws that they may know their legal rights in preventing all kinds of needless injury to their street trees and to guide them in their new plantings along the highways.

A careful study of the following pages will show that it is the intent of these laws to save and protect all street trees, except such as form an actual obstruction to the traffic, which is the primary function of a highway.

FOREWORD.

A copy of the state laws governing the protection and planting of street trees should be in the hands of all citizens of the state either directly or indirectly concerned in the matter. This legislation is of especial interest to farmers, most of whom do not know what their property rights and privileges are in the matter. The initiative in presenting this information was taken by the Department of Forestry which is interested especially in the economic features. The Department of Horticulture, through its activities in landscape work, is jointly interested, especially from the aesthetic standpoint.

R. S. SHAW,
Director.

PLANTING OF TREES ALONG HIGHWAYS.

(Sen. Enr. Act No. 18, Public Act 36 of 1919.)

An Act to regulate the planting of ornamental, nut-bearing or other food producing trees along the highways of the State of Michigan or in public places, and for the maintenance, protection and care of such trees and to provide a penalty for injury thereof, or for stealing the products thereof.

The People of the State of Michigan enact:

Section 1. The State Highway Commissioner and the State Board of Agriculture, acting jointly hereunder, shall have authority and it shall be their duty to select and plant, by seed, scions or otherwise, ornamental, nut-bearing, or other food-producing trees (to be supplied by the Public Domain Commission or the Michigan Agricultural College, as may be recommended or approved by the Division of Agriculture of said college), suitable for shade trees, along the State trunk line highways and all other highways of the State of Michigan, upon which State reward has been paid or earned: Authority of State officers to plant. Provided, That in no case shall such trees be planted except by and with the consent of the owner of the property adjoining such highway. The State Highway Commissioner shall establish rules and regulations for uniform planting or proper placing of all trees under the provisions of this act, and all such trees shall belong to the State, but the products thereof shall belong to the owners of the adjacent land. Proviso. Nothing herein contained shall authorize the State Highway Commissioner, or the State Board of Agriculture to cut down or interfere with shade trees now growing along any such highway, without permission in writing from the owner of the adjoining property. All expenses incurred in carrying out the provisions of this section shall be paid out of any moneys in the State Highway fund that may be available therefor.

Section 2. Counties, townships, cities and villages may annually appropriate money to be used in planting, pruning and protecting, and whenever necessary in acquiring shade, nut-bearing and ornamental trees to be placed along and within public highways within the respective limits of said municipalities. The expenditure of any such fund shall be vested in the highway commissioner of the township upon township roads, in the county highway commissioner in the case of county roads and in the proper highway authorities of the city or village as the case may be. Funds may be appropriated for trees.

Rights of
property
owner to
plant trees.

Section 3. The owner of any real estate in the State of Michigan that borders upon a legal highway upon which State reward has not been paid, shall have the right to plant said approved ornamental, nut-bearing, or other food producing trees along the line of said highway adjoining said land, and shall receive annually a credit of five cents upon his highway repair tax for each tree so planted by him and growing in good order, not less than six feet in height when planted and not less than twenty and not more than forty feet apart. All of said trees and their products shall belong to the owner of said land: Provided, That no bounty shall be paid or deduction allowed under the provisions of this section upon any one tree or row of trees for a longer period than five years. The owner of such trees shall have the care thereof and shall have the duty and responsibility for the trimming, spraying and cultivation thereof.

Provided.

M. A. C.
and Public
Domain
Commission
may grow
and dis-
tribute trees.

Section 4. The Michigan Agricultural College and Public Domain Commission are hereby authorized to grow and acquire suitable seeds, scions or trees for planting under the provisions of this act, and to establish proper rules and regulations for distributing the same at nominal cost, or otherwise, to counties, townships, cities, villages, and citizens of the State for the aforesaid purposes, and also for State parks or other public places.

Unlawful to
cut, injure
or destroy
street trees.

Section 5. It shall be unlawful to cut, destroy, injure, deface or break any ornamental, nut-bearing, food-producing or shade tree upon any public highway or place, except where such trees shall interfere with the proper construction or maintenance of such highways. It shall be unlawful to affix to any such tree any picture, announcement, play-bill, notice or advertisement, or to paint or mark such tree, except for the purpose of protecting it, or to negligently permit any animal to break down, injure or destroy any such tree within the limits of any public highway. Any person violating any of the provisions of this act shall be guilty of a misdemeanor and on conviction thereof shall be punished by a fine of not less than one dollar or more than twenty-five dollars, and in default of payment of any such fine may be imprisoned in the county jail for a period not exceeding thirty days. Such person shall be liable to the owner of the trees for treble the amount of damages sustained.

We are advised that Section 5 protects owners of street trees against the practice of telephone, telegraph and electric power companies from heading or cutting back the tops of trees and otherwise injuring or in any way defacing street or highway trees. The attitude of our court as to the civil liability of such companies when they do deface or injure street or highway trees, is fully presented in the following cases:

Boland v. Washtenaw Home Co., 161/315;

Bolander v. Telephone Co., 182 Mich. 648.

GENERAL HIGHWAY LAW.

§ 4463. Sec. 6. Any person who shall wilfully injure, de-
face, tear, or destroy any tree or shrub planted along the
margin of the highway, or purposely left there for shade or
ornament, or who shall hitch any horse to any such tree, by
means of which the same shall suffer injury, or who shall
negligently or carelessly, by any other means suffer any
horse or other beast driven by or for him, or any beast be-
longing to him and lawfully in the highway, to break down,
destroy, or injure any tree or shrub not his own, standing
for use or ornament in any highway, shall be liable to an
action for damages in a sum not less than one nor more than
twenty-five dollars for each offense, to be recovered at the
suit and for the benefit of the owner or tenant of the land
in front of which such tree or shrub stands, or at the suit
of the commissioner in whose township such tree or shrub
may be situated, for the benefit of the highway improvement
fund for such township.

Injury to
trees, orna-
ments;
hitching of
horses to
trees, etc.

Shade Trees: The policy of our laws favors the planting
and preservation of shade trees in the public streets where
they do not constitute actual obstruction. *Clark v. Dasso*.
34/86. A highway commissioner who has wantonly sold
trees in a highway cannot justify his action when sued in
trespass by the owner by the statute authorizing him under
certain circumstances to order the removal of trees from the
highway.—*Id.* A telephone company, authorized to erect its
line along a country highway, has the right to cut away ob-
structing branches of trees, to admit of free passage of the
wires, without first giving the abutting proprietor an oppor-
tunity to do so, but it will be answerable to him for any un-
necessary, improper or excessive cutting.—*Wyant v. Cen.*
Tel. Co., 123/51. See section 205.

§ 4465. Sec. 8. If any trees shall fall or be fallen by any
person from any occupied land into any highway, any per-
son may give notice to the occupant of the land from which
such trees shall have fallen to remove the same in two days,
and if such tree shall not be removed within that time, but
shall continue in such highway, such occupant shall forfeit
the sum of fifty-cents for every day thereafter until such
tree shall be removed.

Removal of
trees
fell-d in
highways.

§ 4466. Sec. 9. If any person or persons unless duly au-
thorized by the highway commissioner of the township shall
put any garbage, rubbish or waste material of any kind into
any highway of any township of this state, with the intent
to permit the same to remain therein, to the injury in any
way of said highway, or to the annoyance of the citizens of
this state, or any of them, every person so offending shall be

Deposits of
garbage,
rubbish, etc.

deemed guilty of a misdemeanor, and upon conviction thereof shall forfeit and pay a sum not less than five dollars nor more than ten dollars, together with the costs of prosecution, and in default in the payment thereof shall be imprisoned in the county jail of the county in which such conviction may be had not exceeding ten days, or both such fine and imprisonment in the discretion of the court.

Planting and
preservation
of trees.

§ 4467. Section 1. Shade trees shall be planted along both sides of the public highways, at the uniform distance, as near as may be, of sixty feet apart, and not less than twenty-three nor more than twenty-five feet from the center line of the highway, but the township board of any township may direct as to the distance which trees may be set from each other or from the outer line of the highway. All trees now growing upon the sides of any highway, and all trees that may be hereafter planted thereon standing more than sixty feet apart, shall be preserved, and shall not be injured or removed, unless by direction of the commissioner of highways, and with the consent of the owner of the adjoining land, unless such trees shall interfere with or obstruct the travel on the highway: Provided, That the provisions of this chapter in whole or in part shall not be deemed mandatory to townships in which the electors may by vote at a township meeting, thus determine.

Proviso.

The policy of our laws favors the planting and preservation of shade trees in the public streets where they do not constitute actual obstruction.—Clarke v. Dasso, 34/86; Peoples Ice Co. v. The "Excelsior," 44/229.

Removal of Trees: A street railway, authorized by the proper township authorities to lay tracks, erect trolley poles and string wires, is by implication authorized to remove obstructions, including shade trees, without compensation to the owner when such removal is necessary for the construction of the railway as located by the township authorities.—Miller v. Railway Co., 125/171. The law, however, does not give the right to remove shade trees without notice to the owner, and an opportunity given him to remove them.—Id. See DeBoer v. Adams, 159/560.

Commissioner
to cause
trees to be
set out.

§ 4468. Sec. 2. In townships where trees are not planted and growing along the highways as required by section one of this chapter the highway commissioner may cause to be set out each year as many trees as he may deem advisable in his township where the adjoining lands are cleared, but shall not expend to exceed ten per centum of the road repair tax in any one year for such purpose. The commissioner shall particularly attend to the planting of such trees, and shall allow no unsuitable tree nor any tree lacking sufficient roots or vitality to be planted, and he shall have the charge and care of the same: Provided, however, That the cost shall not exceed twenty-five cents for each tree so set out.

Proviso, cost.

§ 4469. Sec. 3. Telegraph companies are authorized to enter upon, and construct and maintain lines of telegraph through, along, and upon any of the public roads and highways, or across or under any of the waters within the limits of this state, by the erection of the necessary fixtures, including posts, piers or abutments for sustaining the cords or wires of such lines: Provided, That said telegraph companies before the construction and erection of said lines and poles, shall first obtain the consent of the duly constituted authorities of the city, village or township through or along which said telegraph lines and poles are to be constructed and erected: Provided, further, That the same shall not be so constructed as to incommode the public use of said roads or highways, or injuriously interrupt the navigation of said waters; nor shall this act be so construed as to authorize the construction of any bridge across any of the waters of this state: Provided further, That this act shall not be construed to authorize any such association to injure, deface, tear, cut down, or destroy any tree or shrub planted along the margin of any highway in this state, or purposely left there for shade or ornament. Said association, instead of running or placing their wires on posts, may, if they choose, run or place the same under ground with a suitable or proper covering for the protection of the same.

Telegraph companies may construct lines of telegraph.

Proviso.

Further proviso.

§ 4470. Sec. 4. Telephone companies shall have power to construct and maintain lines of wire or other material, for use in the transmission of telephonic messages along, over, across, or under any public places, streets, and highways, and across or under any of the waters in this state, with all necessary erections and fixtures therefor: Provided, That said telephone companies, before the construction and erection of said telephone lines and poles, shall first obtain the consent of the duly constituted authorities of the city, village, or township through or along which said telephone lines and poles are to be constructed and erected: Provided further, That the same shall not injuriously interfere with other public uses of the said places, streets and highways, or injure, deface, tear, cut down, or destroy any tree or shrub planted along the margin of any highway in this state, or purposely left there for shade or ornament nor shall the same interfere with the navigation of said waters, or the running of railway trains.

Telephone companies may construct lines

Proviso.

See Mich. Tel Co. v. Benton Harbor City, 121/512. A person desiring to move a building along a public street upon which telephone lines are maintained cannot do so in disregard of the rights of the telephone company, such use of streets not being an ordinary but an extraordinary one.—Kibbie Telephone Co. v. Landphere, 151/309. An adjoining property owner may recover for injuries to his trees that project into the highway and that may be cut or trimmed

by a telephone company whose wires occupy the highway.—
Boland v. Washtenaw Home Telephone Co., 161/315.

Trees to
be for use
of owner.

§ 4483. Sec. 7. All trees standing or lying on any land over which any highway shall be laid out, shall be for the proper use of the owner of such land or person otherwise entitled thereto, except such of them as may be requisite to make or repair the highways or bridges on the same land, or within one mile of the same; but no trees reserved for shade or ornament shall be used for such purposes.

The owner of the land through which a highway passes is the owner of the soil and the timber, except what is necessary to make bridges, or is otherwise required to make the road passable and may maintain trespass for digging into or removing the soil, grass or timber, except when needed for the use of the highway. The public have simply the right of passage over the highway.—Williams v. M. C. R. Co., 2/259.

SHORT SEASON HAY CROPS.

Circular No. 42

BY

C. R. MEGEE, FARM CROPS SECTION.

Due to the frequent failures of clover seedlings the past two seasons, it has been necessary in many instances to turn to annual or quick-growing crops in order that sufficient forage be produced to meet the immediate need for hay or roughage.

The short season crops may be classified according to time of planting as spring and early summer sown crops.

SPRING SOWN CROPS.

Oats and peas. On fertile loam and clay loam soils a mixture of one bushel of oats and one bushel of Canada field peas sown at the rate of two and one-fourth bushels per acre, with ordinary grain drill, as early in the spring as a good seed bed can be prepared, will usually make a very dependable hay crop. On the M. A. C. Station plats the past season oats alone yielded one ton of air dry hay per acre, while the above mentioned mixture of oats and peas yielded one and three-fourths tons.

Oats and vetch. On sandy loam soils, adapted to the production of vetch a mixture of 2 bushels of oats and 20 pounds of hairy or winter vetch, sown early in the spring, will usually produce a good hay crop. Nearly two tons of hay were secured from this mixture on the Station plats the past season.

EARLY SUMMER SOWN CROPS.

Corn. Of all the crops tested corn gave the highest yield of forage and the largest amount of total digestible nutrients per acre. When sown quite thickly in 32-inch rows the ears are not so well developed but the stalks are much finer and practically all of the plant is eaten by the stock. When sown this way the crop may be cut with the corn binder and bound in small bundles which facilitates handling. Varieties which normally reach the glaze or dent stage should be used. On favorable seasons corn may be sown as late as July first and still produce good yields of roughage. Yields of from 7 to 9 tons of dry forage were secured at the Station the past season.

Soybeans. Three tons of air-dry hay were secured by sowing Ito San soybeans on May 20th with an ordinary grain drill, all holes open, using one and one-half bushels of seed per acre. Two and three-fourths tons were secured when sown June seventh. Soybeans may also be sown in 28-inch rows, using 35 pounds of seed per acre. This method will give a higher yield of seed but on the experimental plats did not give quite as high a yield of hay. The seed bed should be well cleaned of weeds and the soybeans sown just deep enough to insure being covered.

The results secured at the Station and from a series of tests conducted over the state indicate that the Manchu, Ito San, Black Eyebrow and Early Brown varieties are among the highest yielders of hay and seed. The Mongol and Hollybrook are well adapted to some sections in the southern part of the state. The Wisconsin Black or Early Black is earlier maturing than Ito San and can probably be grown farther north. The Mammoth Yellow is quite inferior and is not to be recommended under Michigan conditions.

On land where this crop has not been previously grown, inoculation is necessary if best results are to be secured the first season. Material for inoculation may be secured from the Department of Bacteriology, M. A. C., East Lansing, Mich.

Soybean hay is somewhat difficult to cure. Soybeans should be cut when the pods are well formed and before the lower leaves turn yellow and fall off. Best results are usually secured when they are allowed to wilt in the swath the first day, raked into windrows the second and placed in small cocks the third, where they are allowed to cure until safe to store.

Millets. The Golden Millet gave a yield of $2\frac{1}{4}$ tons of air-dry hay when planted on a well-prepared seed bed at the rate of 25 pounds of seed per acre on June 7th. The Hungarian yielded a little less than the Golden and the Common less than the Hungarian. The Hungarian gave an excellent yield of hay on muck. The Japanese Barnyard Millet or Billion Dollar grass is coarser and not as palatable as Golden or Common millet and is not recommended. Millets are shallow-rooted and make their growth in a comparatively short time (50 days for hay), consequently they are exhaustive of the fertility in the surface layer of soil.

Millet should be cut for hay, when the seed is in the late milk or early dough stage. Mature millet seed is oftentimes injurious to livestock, especially horses. For best results millet hay should be fed along with some other roughage.

Sudan grass. This is a comparatively new crop and owing to the high price of the seed in the past, has not become very popular in this state. It should be sown about the same time as millet (June first) at the rate of 24 pounds of seed per acre. The yield of hay secured the past season was slightly larger than that secured from Golden millet, the hay, however, was coarser and more bulky and was from ten days to two weeks later in maturing. Only one crop per season is usually secured in Michigan; however, two or three may be harvested in the southern states.

Sorghums. This crop may be sown solid with the ordinary grain drill at the rate of 40 pounds of seed per acre, or drilled in rows 36 to 42 inches apart, at the rate of from 6 to 8 pounds of seed per acre. The yield secured has been slightly less than that secured from corn sown by the same method.

The Early Amber variety of the Saccharine type is best for Michigan conditions.

Crimson Clover.—Not recommended for Michigan. When sown in the spring it makes a very slow growth and small yield of hay. When sown during the summer it winter-kills badly. Crimson clover is adapted to the region south of the Ohio River.

The following table from Henry's Feeds and Feeding shows the relative amount of digestible nutrients in various plants suitable for hay:

DIGESTIBLE NUTRIENTS IN 100 POUNDS.

Dried Roughage.	Crude Protein.	Carbo-hydrates.	Fat.	Total.	Nutritive Ratio.
Corn fodder.....	3.0	47.3	1.5	53.7	16.9
Sorghum fodder.....	2.8	44.8	2.0	52.1	17.6
Oats and pea hay.....	8.3	37.1	1.5	48.8	4.9
Oats and vetch hay.....	6.9	37.0	1.4	47.1	5.8
Soy bean hay.....	11.7	39.2	1.2	53.6	3.6
Golden Millet.....	4.8	49.7	1.7	58.3	11.1

INCREASING THE PRODUCTION OF THE BEARING APPLE ORCHARD

Circular No. 43

Fruit growers directly concerned in the production of apples and those about to make new plantings should be interested in knowing the prospects of reasonable returns from the expenditure of capital and labor involved in the development of their orchards. A recent survey of the state shows some very interesting changes that have taken place in the acreage of apples and also emphasizes the necessity of better cultural methods to insure larger and more profitable crops.

The farm orchard in Michigan is rapidly ceasing to be a factor in the production of apples in the State, especially in the southern counties. Ten years ago the farm orchard in these counties was a very important factor in the apple production of Michigan. These orchards have now either disappeared entirely or most of the remaining ones are so badly diseased and neglected that they are not capable of producing normal crops. In the northern and eastern counties of the southern peninsula as well as in the counties throughout the fruit belt, the farm orchard is still in fair condition so that in seasons of favorable weather conditions fair crops may be expected. The heaviest loss in acreage in the State has occurred in Hillsdale, Branch, Calhoun, Jackson, Ingham, Ionia and Livingston counties. In Hillsdale county the acreage is estimated as being only 35% of the 1910 bearing acreage. The loss in the other counties ranges from 65% to less than 30% as in the case of Clinton and Shiawassee counties. In the eastern part of the State, the loss has not been so severe as in the south-central and southern counties. Most of the counties in western Michigan show but a slight decrease and in some cases they show a slight increase over the 1910 acreage. In Allegan county the acreage is estimated at 88% of 1910, Berrien 92% and Mason 100%. Oceana county has increased to 105%, Benzie and Leelanau each to 115% of 1910.

*The total number of bearing apple trees was estimated as approximately 4,652,000 trees on June 1st, 1919. Of this acreage about 45% may be classified as sprayed trees; that is, trees that were sprayed at least once during the season. On this basis the sprayed acreage of the State approximates 53,000 acres with an estimated average yield of 45 barrels per acre. The yield of unsprayed orchards averaged about 15% of the yields of sprayed orchards. The yield per acre varies considerably with the care of the individual orchards. This was particularly true during the season of 1919 when a large part of the commercial crop, especially in the southern counties in the State, was found in orchards well-nourished and cultured, or in those on which the crop had been light for the past two or three years and a large supply of stored

*Data furnished by U. S. Bureau of Crop Estimates.

food was available for fruit production. These facts tend to show that the small average production in the sprayed orchards of this State is due primarily to a starved or half-starved condition of the trees, due to poor orchard management. With favorable weather conditions many of the orchards might have set a good crop but due to a poorly nourished condition of the trees they were not able to withstand such adverse conditions for fruit setting as existed during the flowering period of 1919.

In Michigan the center of apple production has been gradually shifting northwestward; in other words, it has been gradually coming under the control of the fruit grower, in distinction to the general farmer.

The new plantings of the fruit growers, however, have not increased the total production of the State, so that while the population of the cities and towns or consuming centers has been growing at a rapid rate, there is no increase of production or plantings, especially since 1914. It is probable that the 1920 census report will show little, if any, increase in acreage of apples throughout the country as a whole since 1910; the new plantings being hardly sufficient to replace the old trees. The present shortage of nursery stock means that it will be several years before enough new plantings can be made to make any material increase in production, while it will be many years before the new plantings will be sufficient to balance the increased population of the consuming centers. These facts should form a reasonable basis for expecting fair prices for apples for at least the next few years.

The prospect of good prices for fruit during the next few years should make the problem of orchard management, to insure maximum production, of serious concern to every grower. The exceedingly small average production of even the sprayed Michigan orchards shows that the immediate problem of the average grower is one of improving his cultural practices to increase his yields of marketable fruit. A study of this problem first directs one's attention to the factors that influence the development and condition of the fruit spur.

FRUIT SPURS AND THEIR DEVELOPMENT.

We may, for convenience, classify fruit spurs into three general groups, insofar as their development is concerned: (1) those of a short, slight growth, without sufficient development and vitality in them to produce a fruit bud; (2) those of slightly stronger growth with a fruit bud of only sufficient vitality to flower but not to set fruit; (3) those of a stronger spur growth with a plump, vigorous fruit bud able to set and mature fruit.

Most of the spurs on a non-productive apple tree belong to the first group. The history of trees producing such spurs frequently shows a rather satisfactory growth in the earlier years, especially during favorable seasons; comparative early bearing of the trees continued for a few seasons, after which a cessation of growth occurred and then of fruit production; the tree had exhausted the food supply within reach of the roots to such an extent that further growth and production was inhibited. This is the present condition of many Michigan apple orchards and usually is the characteristic condition of neglected orchards. (See Fig. I.) Severe winter pruning is often resorted to by the grower to "re-invigorate" such trees, often resulting in temporarily restoring their

fruitfulness but at the expense of losing a considerable part of the fruit-producing area in the tree. To maintain fruitfulness by this method, such severe pruning must be repeated each successive year which, of course, would hardly be feasible. This explains the results often attained in orchards that have been neglected, where the owner or renter severely pruned such trees and by careful spraying obtained fair crops for a season or two.

Many of the orchards on the farms in this State are in the condition of Group 2. Such trees usually produce an abundance of fruit spurs, which, while not vigorous, are sufficiently so to produce weak fruit buds usually in alternate years. A heavy bloom occurs usually biennially but a very small percentage of the spurs set fruit except with very favorable weather conditions prevailing at the flowering time and for the first few weeks after flowering. When such trees fail to set fruit after heavy flowering, unfavorable weather conditions, a lack of pollenizing insects, infertility of the variety, insects and diseases, are a few of the most common reasons given for such failures in fruit setting. A most potent factor, however, is a lack of vitality in the fruit spur to properly stimulate and nourish the setting and development of the fruit. After the production of a fair crop, such trees require the following season or two to recuperate and store up sufficient food for another good crop and are thus referred to as biennial bearers; that is, bearing crops every other year except when weather conditions interfere.

The most productive apple orchards in the State belong to the third group. The spurs produced are strong and vigorous, indicating an adequate stored supply of food, a large conducting tissue in the spur for supplying sap to the young growing fruit, and large, plump, vigorous fruit buds. (See Fig. II.) The leaves produced on such spurs are large and dark-colored and the fruits are also of good size. Generally trees producing a large percentage of such spurs are quite annual in their producing habit. This may be explained by the fact that there is sufficient plant food to nourish the spurs developing fruit and also to induce a vigorous, new spur-growth for fruit production the following year. The plant food supply is not all required to mature the crop but much is left for new fruit spur development. Where a tree is under-nourished, such new spur development is restricted the season a crop is being matured.

While weather conditions will always be an important factor in fruit setting, it is important to know that flowers on strong spurs are more apt to set fruit than those upon weak spurs. This is due to the fact that in weak spurs the stimulating and drawing effect of numerous seeds, the formation of which requires favorable weather conditions during the flowering period, seems to be necessary to supplement the natural forces in attracting enough moisture and plant food to the young fruit; but in strong fruit spurs the young fruits seem to obtain a sufficient supply of food without this supplementing effect of numerous seeds.*

While one cannot exercise the control over weather conditions to insure thorough pollination at the flowering time for seed development, it is possible to exert much influence over the vigor of the fruit spur and thus tend to insure crops even during seasons when weather conditions are not most favorable. This was one of the most important factors in determining the size of the apple crops in southern Michigan

*Dr. Heinicke's Bulletin, Cornell 393.

orchards during the season of 1919. The problem, then, of developing strong, vigorous fruit spurs most capable of setting fruit is a most important one to insure profitable crops.

FACTORS FAVORING GROWTH.

A fruit tree during its season of growth is constantly striving to place itself in equilibrium with the forces of its environment. It is therefore never stationary in its condition; it is ever changing from day to day, month to month, and season to season. The atmospheric conditions of its environment are always changing, especially those of tem-



FIG. 1. WEAK FRUIT SPURS CHARACTERISTIC OF NON-PRODUCTIVE TREES.

perature, light and humidity, all of which influence growth and may be limiting factors of production. The soil conditions affecting growth are likewise ever changing in the supply of available plant food elements, in temperature conditions and in moisture content. It is this ever-changing condition of the soil content that more often largely determines whether the resulting changes in tree-growth are favorable or not for fruit production.

Soil moisture is a most important necessity for plant growth that is often a limiting factor. All plant food in the soil must be taken through the medium of soil moisture. It must be dissolved in the water of the soil before it is available to the plant. Hence, a fruit tree in the richest soil may starve at such times as when soil moisture is wanting. This principle emphasizes the necessity of such cultural practices as will insure an ample and uniform supply of soil moisture during those

periods when the fruit spur is developing and storing its food supply for the following season; also, during the setting and developing of the fruit. Maintaining a high organic content of the soil, to enable it to hold more soil moisture, by manuring or cover-cropping, heavy mulching with straw, and the early plowing of cover crops followed by regular cultivations, are practices which tend to insure an ample and uniform moisture supply.

While the temperature and moisture conditions of the soil are factors

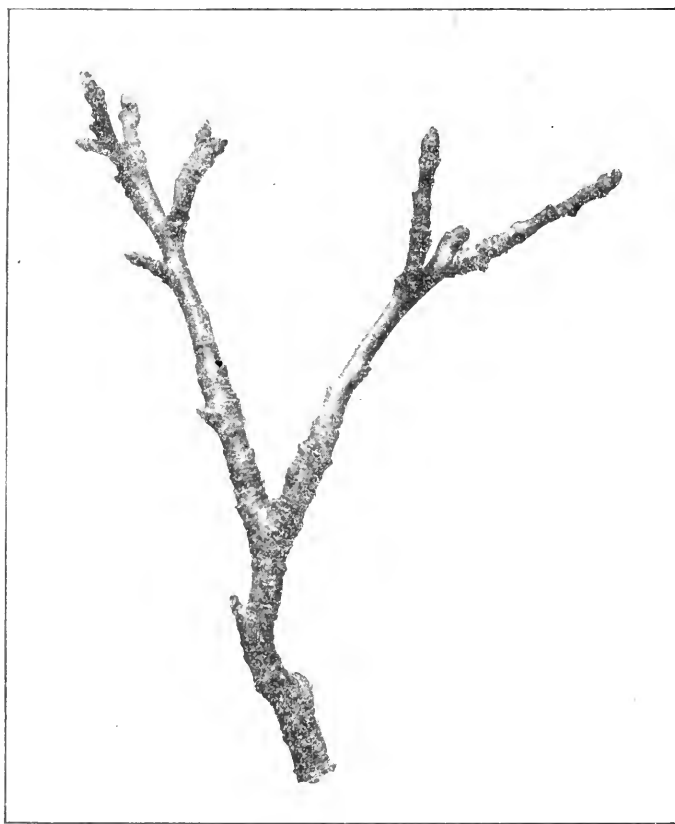


FIG. 11. A STRONG FRUIT SPUR CHARACTERISTIC OF PRODUCTIVE TREES.

that greatly influence growth, the availability of the chemical elements in the soil is a most common limiting factor. This deficiency of available chemical elements in the soil may be due to the fact that the soils are "infertile" or are deficient in one or more of these elements. Other orchard soils are rich enough but the elements are not in available forms at the most favorable season for growth. Studies of the Soils Department on the relative availability of nitrogen, phosphorus, potash and such other essential elements in the soil at different periods of the growing season show that in very early spring there is a very slight amount of these elements present in available forms. As the season

advances, the soil temperature rises and the relative amount of these elements in available forms increases, reaching a maximum about the middle of the summer and then declining until in the fall there is again practically no soluble plant food in the soil. In mid-summer when these elements are most available in the soil, fruit spur growth should be about completed. During the earlier part of the season is the period when available nitrogen is most essential in promoting the development of strong fruitful spurs and in favoring fruit setting. Phosphorus and potash, while also essential, do not seem to be required quite so early in the season. The problem of the grower, therefore, is to use such cultural practices as are necessary to insure an adequate supply of these essential elements as they are required for fruit growth.

There are several practices that may help to insure this supply. Annual moderate pruning of the trees during the winter or early spring indirectly helps to compensate for this deficiency since there will be a smaller top growth to support. The early spring plowing of cover crops that are still in a green, succulent condition and that will decompose quickly and soon become available to the plants will tend to favor growth. The early cultivation of orchard soils following plowing tends to liberate plant food at this season. The application of fertilizer early in the spring, either as decomposed stable manure or in such commercial forms as will soon become available to the plants, may prove most beneficial in encouraging an early, vigorous spur growth.

The ideal of the Michigan fruit grower handling a bearing apple orchard on the soil mulch system should be to furnish and maintain the organic and nitrogenous content of the soil by the growing of cover crops supplementing this practice by the addition of potash in the commercial form and more frequently of phosphorus when such happen to become limiting factors of production. In commercial practice, however, especially on light soils, it may frequently be found advantageous to supplement the nitrogenous content of the soil by moderate applications of some quickly available form of nitrogen, applying it early in the spring. As a matter of fact most growers are not maintaining either the organic or nitrogenous content of their soils by cover cropping as is evidenced by the present condition of their trees and the crops produced. As stable manure in sufficient quantities is rapidly becoming a thing of the past, growers are bound to turn their attention more to the commercial forms of fertilizers and unless used judiciously they are quite apt to be disappointed with the results.

COMMERCIAL FERTILIZERS.

Commercial fertilizers can never be considered as full substitutes for stable manure. They do not furnish the organic matter to the soils to keep them mellow, friable and capable of holding moisture and it is only when this physical condition of the soil is thus maintained that the best results can be obtained with commercial fertilizers. Recent tests have demonstrated that when commercial fertilizers are used the results will also depend greatly upon the time of application and the availability of the forms used.

Investigations on the causes of apple blossoms failing to set have shown that this condition is closely associated with the question of plant

nutrition and that strong spurs, well supplied with water and food, are a very important requisite to self-fertility.* It is now considered advisable, therefore, to apply the fertilizer just as early in the spring as growth begins if the effect on the setting of the present season's crop and on the formation of fruit spurs for the following season are desired, using such quickly available forms as nitrate of soda or sulphate of ammonia for the nitrogen, acid phosphate for the phosphorus and muriate or sulphate of potash for the potash. Whether any or all of these three essential elements of plant food are deficient in any particular orchard soil is the first question to consider. A soil analysis will not conclusively prove this point. A close observation of the present or previous season's growth and production of the trees and a consideration of the general type of top and subsoil, together with the way in which the soil has been handled, should lead to an estimate of the probable deficiencies of the soil.

Nitrogen. Weak vegetative growth as characterized by a short, thin, new twig and spur development and by the production of small light-colored leaves is generally associated with a lack of nitrogen in the soil. The sandy or gravelly loam soils that characterize our fruit sections are particularly apt to be deficient in this element. Recent experiments have shown that a lack of nitrogen in the soil especially during the early period of growth, is a most common limiting factor of fruit production with mature trees.*

Orchards on strong clay loam soils that are well cultivated and cover-cropped are not so apt to be deficient in this element. When trees are making an excessive vegetative growth as characterized by the production of long, vigorous, new twigs, large heavy dark green foliage, possibly preventing the proper coloring of the fruit or delaying the tree in coming into bearing, it indicates an over-supply of nitrogen. This may be checked by the practice of very light pruning, by light cultivations supplemented with non-leguminous cover crops, by cropping the orchard, or by seeding it down for a season or two. Such a condition, while not very general, is apt to prevail on the fertile clay loam soils, particularly about the time the trees have reached a bearing age which may be considered as a transitional stage from that of vegetative growth to fruit production.

The amount of nitrogenous fertilizer that should be applied to trees is largely a matter of estimate based upon the probable degree of deficiency of this element in the soil and the size of the tree. If nitrate of soda is the source of nitrogen used, from 3 to 6 pounds per tree will generally be found desirable. As nitrate of soda tests about 16% nitrogen, this would mean that from one-half to one pound of actual nitrogen was being applied per tree. Upon this basis the proper amount of sulphate of ammonia or other nitrogenous fertilizers to apply could be estimated.

Phosphorus is an element that is also frequently the limiting factor of growth and of fruit production on the orchard soils of this State. Investigations of our Soils Department show that the sandy loam soils and sandy soils of our State are commonly low in phosphorus. When phosphorus is deficient in the soil and the moisture and nitrogen supply

*Dr. Heinicke, Cornell Bulletin 393.

*Krause & Kraybill, Oregon Bulletin 119.

sufficient, it may affect growth and production in quite a similar manner as when nitrogen is the limiting factor. The production of new growth is inhibited, the leaves are light and yellow in color and the trees as a whole appear devitalized. Under such conditions an application of acid phosphate results in a vigorous vegetative growth of strong, healthy shoots with large, dark-green leaves, showing that the unbalanced condition of the soil for growth has been adjusted. From 5 to 10 pounds of acid phosphate per tree should be used in fertilizing mature orchards under these conditions, the exact amount being estimated by the apparent degree of deficiency of this element as well as upon the size of the tree. Beneficial results may be expected on such soils from subsequent applications every second year.

Potash. While potash is another essential element for plant growth that is sometimes deficient in the soil, it is not so frequently a limiting soil factor in Michigan as nitrogen or phosphorus. This element seems to be most directly concerned in the development of strength and sturdiness to the twigs, foliage and branches and in the maturing of the plant tissues and fruit. Apparently, this element is not so essential during the earlier season of growth and later in the season the average soil of this State seems to contain enough available potash for the requirements of the tree. However, when an application of potash seems necessary, from two to three pounds of muriate or sulphate of potash should be applied per tree.

While much information as to the probable deficiency of an orchard soil may be obtained through studies of the soil, and by the growth and production of the trees, the surest method of ascertaining a soil's deficiency is by an actual orchard test. Such a test should precede any extensive application of commercial fertilizer when no very definite indications of deficiencies are apparent, or when no such orchard tests under similar conditions have been made in the locality. The simplest orchard test for this purpose would consist of three plots using three or more trees to a plot with a check or unfertilized row of trees between each. To one plot nitrate of soda might be applied; nitrate of soda and acid phosphate to the second; nitrate of soda, acid phosphate and muriate of potash to the third. Such tests would indicate whether any or all of these elements were needed. A general application based upon these results could be quite safely made to the entire orchard the following season. The amount to use from year to year will continue to be a matter of estimate based upon the results obtained from the previous season.

PRUNING.

There are few mature apple orchards in this State that have not suffered from the pruning saw. Injudicious pruning of apple trees has been such a common fault that some growers are turning to the opposite extreme in believing that trees are better unpruned. The degree of pruning required by a tree and the results that may be expected are so intimately dependent upon the condition of the tree and so closely associated with the food and moisture supply of the soil that no simple formula for pruning can be offered.

Many fallacies exist in the minds of horticulturists regarding the

effect of pruning upon growth and fruit production, but much light has been shed upon this subject by recent investigations.

The pruning of trees while dormant has been commonly regarded as a practice that results in increased vigor of the plant. Since severe dormant pruning usually causes a stimulated vegetative growth of the remaining branches, it might appear that such was the case, especially if judgment is based on the length of twig growth of the remaining parts the following season. Annual twig growth alone, however, is not a correct index of a tree's vigor. Studies have shown that the total amount of wood laid down over the entire plant is a more accurate index of a tree's vigor. When a tree is severely pruned during the dormant season, the equilibrium that naturally exists between the top and root systems, as determined by the environment and food supply, is broken. While this results in a more rapid vegetative growth of the remaining parts after pruning, this growth is not sufficient to compensate for the loss of branches caused by pruning and for the new growth that otherwise would have been produced. So far as the effect on growth is concerned, the less a tree is pruned the larger and heavier it becomes. Therefore, pruning is at the expense of total growth rather than resulting in a gain in total growth.

It is also sometimes considered that a heavy pruning of the top induces a renewed and strengthened root development. A study of plant physiology reveals the dependence of root growth upon the food supply assimilated in the leaves. Any severe reduction of foliage naturally limits the food supply to the root system, which in turn proves a limiting factor of root growth. Severe top pruning, therefore, tends to retard root growth and development rather than to stimulate or invigorate it.

While pruning results in a more rapid vegetative growth of the remaining branches, its effect upon fruit production is less definite; the results depend largely upon the vigor of the tree, the degree of pruning practiced, and the character of the pruning. The heavy pruning of trees already in a vigorous condition of growth encourages further vegetative development at the expense of fruit production. Heavy pruning of trees just coming into fruiting further retards the time of bearing. When the lack of fruitfulness, however, is due to what is called a "general devitalized condition" of the tree as characterized by little, new spur or twig growth and small light-colored foliage, dormant pruning results in a stimulated growth of the remaining spurs and twigs which in turn may or may not result in increased fruit production. This so-called "devitalized condition" of the tree Krauss has found is caused by an accumulation of the carbohydrates to such a degree in excess of the available soil nutrients that their efficient utilization is prevented. When a tree has reached the period of full bearing, its roots have penetrated all the available soil area so that in soils of but moderate fertility the proportion of soil nutrients absorbed to that of the leaf area, which in turn measures the carbohydrate supply, is apt to become less each year. The nitrogen and other soil nutrients then become the limiting factors of fruitfulness and growth. While pruning will not increase the supply of nitrogen and other food elements in the soil, it reduces the supply of carbohydrates and in that way tends to readjust this balance. Even under these conditions if the

pruning is too severe, it will reduce the supply of carbohydrates to such a degree that all remaining will be utilized by the soil nutrients in vegetative growth and hence no storage of this material which seems necessary for fruitfulness can take place.

While the severe pruning of trees that are not productive, due to a limited supply of food material in the soil, may result in greater fruitfulness, it is a question if this is the wisest method of bringing about



BEFORE PRUNING.

Fig. III. A Spy tree before pruning showing an accumulation of numerous small branches over the outer portions forming a dense top.

this desired change of condition since such pruning necessarily results in decreasing the fruiting area of the tree. It is usually a better practice, even under such conditions, to prune lightly and to readjust this balance of soil nutrients to carbohydrates by proper fertilization of the soil and proper cultural practices.

Having in mind the general effects of pruning upon growth and fruitfulness which should form a basis for estimating the relative total amount of pruning required in relation to these factors one is then ready to consider the other aims and purposes of pruning practices that determine more specifically just what parts should be removed.

Pruning is largely a practice of adjusting the direction of growth pro-

duced and of directing the forces of future growth. During the earlier years of the tree's existence, pruning is primarily a training process in which the tree is assuming its future matured form which is determined by the combined forces of its inherited character of growth, its environmental conditions and the direction in which its forces of growth are led to take by pruning. Since the natural habit of growth and the forces of environment do not result in a form of tree that best meets the economic conveniences of good orchard practices or does not re-



AFTER PRUNING.

Fig. IV. Same tree as shown in Fig. 3. Outer branches have been thinned out and top moderately reduced.

sult in a form that is capable of producing maximum crops without the breaking down of the branches, these objects must be sought by pruning. While this function of pruning is relatively of greater importance during its formative period, that is, before the tree comes into bearing, it must be considered, nevertheless, even with mature trees.

The greatest stimulative effect of pruning on growth is in closest proximity to the cut. Hence, in pruning wood of the past season's growth, the bud left nearest the end generally produces the greatest growth the following season. The growth of the lower buds is less as the distance from the cut increases. As the direction of this bud largely determines its direction of growth, the direction of the future branches is greatly influenced by the direction of the buds left nearest the end.

In pruning older branches they should be cut close to other lateral branches or close to the trunk. When stubs are left in pruning, there is no growing point to act as a drawing force in directing the sap to the wound. As a result the wood fails to callous and the tissues start to decay, resulting later in heart rot.

If it is desired to renew vegetative growth throughout the tree as a whole, the pruning should be well distributed over the entire tree by thinning out the numerous small outer branches not usually more than one inch in diameter, rather than by pruning a few large branches and thereby leaving great openings in the tree. This thinning out of numerous small branches near the outer parts of the tree will also allow a



TOPPING TREES.

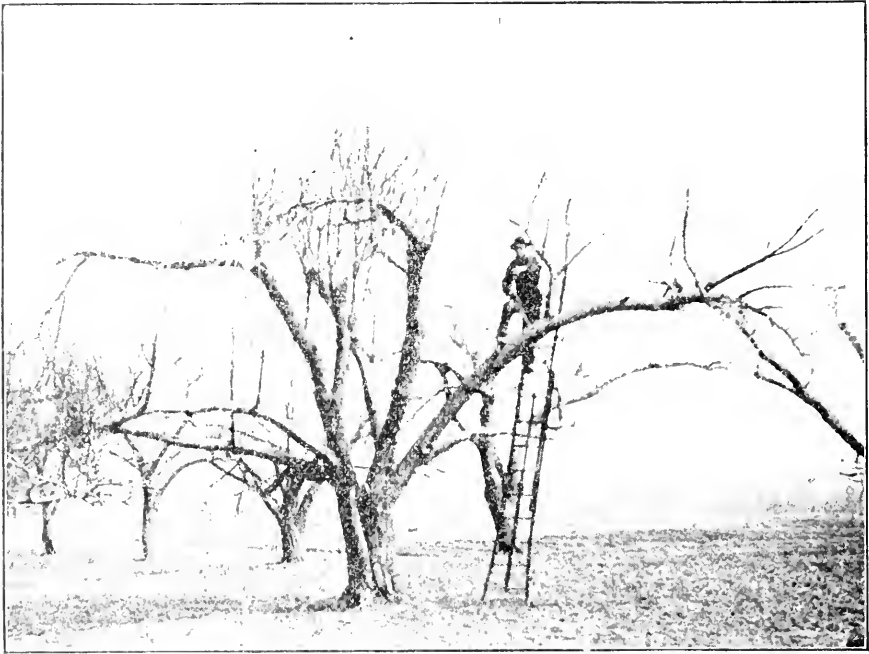
Fig. V. Such severe pruning to reduce the height of the tops is not recommended.

more equal distribution of light to the central parts, provide a better circulation of air and permit more thorough spraying. The cutting out of a large branch is usually followed by an excessive vegetative or sucker growth just below the wound; it exposes the other large branches below and in its vicinity to sunscald and reduces the fruit-bearing surface of the tree. The smaller fruit-bearing branches throughout the inner portions of the tree should be conserved as much as possible to encourage fruit production there as well as near the outer parts.

Pruning is often a desirable means of encouraging a development of lateral branches and thus correcting or preventing the production or development of long, rangy branches that would later be quite subject to splitting or breaking when laden with fruit. By heading back a long rangy branch close to a lateral branch, a more stocky form may be developed. Such stocky branches can carry a much larger load of fruit without danger of breaking or splitting.

Heading back is also a means of maintaining or destroying the balance between two branches that happen to be growing from or near a common point. If two such branches have made about the same amount of growth and are left unpruned or are cut back the same degree, equal growth will be produced the following season. Such a condition frequently results in the development of a crotch that makes the branches very subject to splitting. To prevent this condition one branch may be cut several inches shorter than the other; the longer branch will then give rise to more growth and become the leader, while the shorter one will become one of its laterals.

When watersprouts develop on the main branches they should be re-



TWO YEARS AFTER TOPPING.

Fig. VI. Same tree as Fig. 5. Large limbs severely injured by sun-scald. Suckers forming new top.

moved by close pruning except when desirable for filling up vacant spots through the tree for fruit production. Under such conditions, the sprouts left should be headed back to induce lateral branching. The following year it may also be desirable to shorten some of the lateral branches produced but after this time heading back should cease. All branches tending to develop in the wrong direction or tending to cross other branches should be headed back or entirely removed and, of course, all dead branches should be cut out.

Topping trees. Most growers appreciate the difficulty of spraying, thinning, and harvesting fruit on high-topped trees. This difficulty often leads to the practice of reducing the tops to the desired heights by severe pruning to produce low, round-topped trees. This sudden

reduction of the tops is generally followed by an excessive production of sprouts on the main branches and usually by severe sunscald of the bark on the larger limbs. This practice, therefore, leads to serious injury of the trees, and many orchards of the State are monuments of the disastrous results often following this practice. One should not attempt to change to any great degree the form of a mature tree. The height of the uppermost branches of a high-topped tree may be gradually reduced to a moderate degree by successive light prunings over a series of years, but not by removing so much growth at any one time as to upset the balance of the tree or expose the remaining branches to sunscald.

PRACTICAL RULES FOR GUIDANCE.

Mature trees should be pruned annually but moderately.

Remove all dead branches and watersprouts except such of the latter as are desired for fruiting wood, thinning out as many of the outer branches where the growth is too dense and as many of the branches growing in undesirable directions as the present vigor of the tree and fruiting record would seem to permit without seriously disturbing its equilibrium.

It is better to increase vegetative growth by feeding, cultivation, and cover-cropping than by excessive pruning.

Make all cuts clean and close and see that all wounds have good surface drainage.

On trees infected with bark cankers, prune only such branches that seem of most urgent necessity as each wound is apt to prove a new infection point for such troubles. Disinfect the pruning tool after each cut to prevent the possibility of spreading the infection by the pruning tool.

Do not jeopardize the present health and fruitfulness of high-topped trees by excessive pruning to make them low and round-topped. To moderately modify such high-tops requires time, patience, and skill.

COVER CROPS.

While it has been a general practice for a number of years to cover-crop tilled orchards, the importance of efficient cover-cropping bears a new significance in its value under the changed conditions of the times. This is due particularly to the present reduction in the supply of stable manure from the cities for orchard fertilization, and the present necessity of increasing and maintaining the organic content of the soils to increase production.

The loss of fertility of many of the orchard soils is due largely to the decrease in the amount of humus that they contain. Humus is the product of the partial decay of organic matter and is considered a necessary ingredient of fertile soils. Most of the nitrogen of the soil is present in the more or less decomposed organic matter. Besides nitrogen, this organic matter either contains phosphoric acid and potash in available forms or assists in making them available from the mineral elements. Under natural conditions, the humus in the soil resists decay. Tillage in an orchard is therefore practiced and is desirable because it hastens the decay of this potential plant food by

providing better conditions for its decomposition in the soil. As the humus of the soil is reduced by successive cultivations and cropping, the nitrogen content of the soil, its water-holding capacity, and crop production are likewise decreased. This emphasizes the necessity of annually replacing the organic matter lost through decomposition to maintain soil fertility. While cover-cropping is the most economical means of annually furnishing this organic matter, many growers are not producing enough humus with their cover-crops to replace it as fast as it decomposes; hence their orchard soils become less productive each year. Humus is also very essential because it improves the physical condition of the soil; it makes a loose, sandy soil more compact, while it loosens up a hard clay soil making it more friable and mellow.

The beneficial effects of a cover crop on growth and fruit production is, therefore, largely dependent upon the amount of humus and nitrogen in the crop returned to the soil; in other words, the greatest effect may be expected with the crop that consistently furnishes the greatest amount of vegetable matter each year. It has been found that while a crop like soy beans may be richer in nitrogen and also may add aerial nitrogen to the soil, yet some other non-leguminous crop may improve the soil conditions more, affecting growth and fruit production because of its greater bulk of organic matter.

The degree of benefit derived from the use of cover crops is also dependent upon the time the crops are sown, the time when they are turned under, and the adaptation of the crop to the soil and orchard conditions.

The necessity of an abundant supply of soil moisture and nitrogen, as soon as growth begins, to insure a good setting of fruit and to stimulate early spur-growth, is not always well appreciated by the growers. Too many defer the turning under of the cover crops until late spring. Under these conditions the plant food in the cover crop does not become available to the trees soon enough to be most beneficial, especially on the crop of that season. The maintenance of the fruits upon the fruit spurs to prevent an excessive "June drop" is largely dependent upon an ample supply of moisture and plant food. The production of vigorous fruit spurs for the production of fruit buds for the crop the following year infers an early cessation of growth to permit a proper storage of food in the bud and spur. Early plowing or disking-in of the cover crop as soon as growth begins is very desirable; also the seeding of the crop earlier in the summer than is frequently practiced, early July being preferable to early August unless soil moisture proves a limiting factor in seasons when the trees are producing a heavy crop.

Cover cropping has many other desirable functions. The cover crop absorbs the plant food that becomes available in the soil in late summer and fall that might otherwise leach away, returning it to the soil at a season when the trees can most readily use it. It is of value in catching leaves that drop in the fall and that otherwise might blow away. The value in this respect is emphasized by the following table:

Value of Crop in Catching Leaves and Preventing them from Blowing Away.

Baldwin apple tree of bearing age and normal size produced..	80	lbs.
Rhode Island Greening	81	lbs.
Champion Peach	46	lbs.
Elberta	38	lbs.
Hills Chili	52	lbs.
Kieffer Pear	38	lbs.
Italian Prune	19½	lbs.

Such a mass of organic matter produced annually from a tree should be conserved and returned to the soil.

Cover crops are advantageous, also, in covering the soil in winter to hold the snow, preventing deep freezing, and preventing soil erosion. All of these factors are of great importance in managing an orchard and emphasize the desirability of good cover-crops.

SUMMARY STATEMENT.*

Cover-cropping is the most available means of the fruit grower in maintaining or increasing the organic content of the soil.

This organic matter is necessary to maintain its physical condition, to increase the water-holding capacity of the soil, and to act on the mineral elements in making them soluble in soil moisture and thereby available to the plants.

Leguminous cover crops have the further advantage of adding nitrogen to the soil.

The degree of benefit derived from their use is measured by the amount of organic matter and nitrogen in the crop returned to the soil; by the time the crops are sown; the time when they are turned under; and by the adaptation of the crop to the soil and orchard conditions.

The annual production of Michigan apple orchards could be greatly increased by combining an intelligent use of commercial fertilizers, judicious annual pruning, and efficient cover-cropping and tillage.*

*For further details on cover crops, send for Special Bulletin No. 18.

*Detailed directions of spraying orchards may be found in the Spray Bulletin which may be obtained upon request to Dir. R. S. Shaw, East Lansing, Mich.

THE EFFECT OF FERTILIZER SALTS TREATMENTS ON THE COMPOSITION OF THE SOIL EXTRACTS.

Technical Bulletin No. 45

C. H. SPURWAY, SOILS SECTION, MICHIGAN AGRICULTURAL EXPERIMENT STATION.

Historical.

Since the time of Liebig and Boussingault agricultural investigators have manifested great interest in the effects of fertilizer salts on soils and crops. Considerable work has been done along this line and the literature on the subject is very voluminous, so that practical difficulties do not permit of a complete review here. Sufficient reference material is given, however, to show the trend of results so far obtained.

Storer (29) gives results from Boussingault's work showing that CaSO_4 liberates P, K, SiO_2 , Mg, S and Cl from the soils experimented upon, and in one case Na and oxides of Fe, Mn and Al collectively, because greater quantities of these elements were found in the ash of clover grown on a treated soil than were found in the same crop from the same kind of soil untreated. Several other investigators have studied the power of CaSO_4 and other chemicals to liberate K from soils and soil forming rocks, with various results. Bradley (4) working on some Oregon soils, found that gypsum increased the solubility of K in the soils and also in feldspar but the effect of lime in this respect was slight. Curry and Smith (8) claim increased solubility of potash in some New Hampshire soils by use of NaCl , NaNO_3 , and Na_2CO_3 , while lime and CaCO_3 had practically no effect. Similar results were obtained from Na salts by Tressler (30), who also found that CaSO_4 liberated K from some soils, and the effect was more marked on a clay than on either a silt or sand. McMiller (24) also claims that gypsum liberates K from certain Minnesota soils, and Wheeler (32) gives data to show that NaCl , NaNO_3 and Ca salts may liberate some K from soils. Some investigators obtained results differing from those just stated. Plummer (26) found that $\text{CaH}_2(\text{CO}_3)_2$ did not increase the solubility of K in biotite, muscovite, orthoclase or microcline. That lime does not increase the available K in soils is also stated by Gaither (13). Fraps (11) claims that Na_2SO_4 , NaNO_3 or other salts have little effect on the solubility of K in soils, but that CaCO_3 and organic matter liberate K to some extent. Briggs and Breazeale (1), however, state that $\text{Ca}(\text{OH})_2$ had practically no effect in liberating K from pegmatite, orthoclase or granitic soil. These authors also found that the solubility of K in orthoclase was depressed by gypsum. Lyon and Bizzell (19) also place little emphasis on the effect of lime in liberating K from soils. These results seem to show that the solubility of K in potash bearing rocks and soils is increased very slightly if at all by hydrated lime, lime or CaCO_3 but that in this respect CaSO_4 and Na salts act differently on different rocks and

soils. One is led to conclude that the effects of neutral salts in liberating K from rocks and soils depend upon the chemical and physical state of the K in these materials.

The situation with respect to liberation of P from soils by various treatments is similar to that of K, however, the results of investigators show that P in certain compounds is made more soluble while that in other forms is not affected. Wagner (31) was probably the first to show that NaNO_3 dissolved phosphates in the soil; while Liebig (20) and Lawes and Gilbert (21) seem to have observed that ammonium salts increased the solubility of soil phosphates. The quantity of water soluble phosphates in soils was not increased by lime or gypsum, Bradley (4). Greaves (12) in an extensive investigation of this problem observed that the solubility of phosphates is decreased in general by Ca and Fe salts, but that Na_2SO_4 , CaSO_4 , $(\text{NH}_4)_2\text{SO}_4$, NH_4Cl and NH_4NO_3 increase their solubility; while the solubility of calcium phosphates was increased and of iron phosphates decreased by NaNO_3 and KNO_3 . This same author states that the effect of MgSO_4 , NaCl , MgCl_2 and KCl , varies with the kind of phosphate, but the solvent action of all compounds is more vigorous in presence of the soil. Cameron and Bell (9) working on pure compounds give data to show that lime salts depress the solubility of lime phosphates, while neutral salts and acid solutions have the opposite effect, also, that hydrolyzing salts increase the solubility of iron and aluminum phosphates and neutral salts have only a slight action on them. Hartwell and Kellogg, (15), Kellner (17) and Sutherst (28) claim that lime increases the solubility of soil phosphates. The last named author and Gaither (13) state that lime is especially effective on iron and aluminum phosphates. CaCO_3 is not effective in dissolving phosphates, Sutherst (28); and Lyon and Bizzell (19) found no relationship between liming soils and P removed from them by cropping or leaching. While considerable difference of opinion prevails among investigators it appears that soil P may be made more soluble by the common fertility treatments.

Researches have repeatedly shown that other soil elements may be dissolved by various treatments. Ca and Mg may be lost from the soil in considerable quantities through fertilization as shown by Collinson and Walker (7), references cited by Lyon and Bizzell (19), Wheeler (32), the work of Cameron and Bell (10) and many others. That NaNO_3 , NaCl , and Na_2SO_4 increase the solubility of CaCO_3 in soils has been shown by Breazeale (2). Studies on adsorption and basic exchange in soils by numerous authors prove beyond doubt that Ca, Mg, Fe, and Al are liberated in soils by certain neutral salt treatments. The work of Monnier and Luczyaski (25) is especially interesting in this connection because they state that CaCO_3 and MgCO_3 precipitate Fe in the soil as a basic carbonate which gradually changes to a hydrate and little is found in the soil extract. In general, experimental data appear to indicate that the results obtained depend somewhat upon the materials used and quantities of reagents added to them.

The Problem.

The composition and concentration of soil solutions as affected by soil treatments is undoubtedly of great importance in practical agriculture. King (18) and more recently Burd (3), Stewart (27), Hoagland

(14, McCool and Millar (23), Bouyoucos and McCool (5), Bouyoucos and Laudeman (6) and others, have produced data showing a close relationship between composition and concentration of the soil solution and plant activities. That the solution in various soil layers changes in composition as soluble salts move through soils is shown by McCool and Wheating (22). These changes in composition must surely affect solubilities of soil elements and growth of plants.

The problem undertaken in this research was suggested by Dr. M. M. McCool, it being the general policy of the members of the Soils Section to attack the problem from the physical and chemical angles and when thought desirable and practicable, from the field standpoint as well. It is the outgrowth of other work of a similar nature performed at this Station and cited above, in which solubility of soil minerals under different treatments and movements of soluble salts in soils were studied principally by means of the freezing point method of determining concentrations in soils and soil extracts. It was thought advisable to support this work by an extensive chemical research to determine if possible the extent of the effect of various treatments upon each soil component as well as the reactions involved. It was also planned to study the residual as well as the immediate effects produced by the treatments.

Experimental.

Four sandy loam soils as nearly true to type as could be obtained without mechanical analyses were selected for experimentation. Two of the soils were alkaline to litmus paper and two were acid. These soils had been treated with manure in the fields, but never with commercial fertilizers so far as could be ascertained. Analyses of the soils are given in Table 1. The soils were prepared by passing the fine material through a ten mesh sieve, they were then air dried in the laboratory, and stored in galvanized soil bins. The four soils were treated in duplicate sets with nine different fertilizing compounds in the following manner: 1 gm. of oven dried fertilizing material was intimately mixed with 1 kg. of air dried soil, the soil placed into a four litre aspirating bottle the neck of which was fitted with a small cork. The bottle was then inverted and placed on a ring support and the soil saturated with distilled water (500 c.c.) through the bottom tublature which was finally fitted with a cork. After standing two days the treated soils were leached with about three litres of distilled water in 500 c.c. portions, the small cork in the rubber stopper removed to permit percolation and the water admitted through the tublature of the bottle. Electrical resistance measurements were taken for concentration of the several portions and some of them were tested for reaction by litmus paper and boiling with phenolph-thalein indicator. Equal quantities of solutions were removed where necessary for these tests so that the analytical results would be comparative. The soils were then left saturated for a period of fifteen days and the leaching procedure repeated. The soil extracts were then made exactly to three litres using the last 500 c.c. portions in each case for the final measurements. Chlorine, carbonates, reaction and in some cases nitrates were determined on these natural extracts, after which they were treated with 1 c.c. of concentrated nitric acid to flocculate colloidal material and concentrated so that analytical determinations in milligrams represented parts per million on the soils.

Results are averages of duplicate determinations and except as otherwise stated are given as parts per million on soils. A complete report of the experimental procedure is given in this paper.

The chemicals used were KCl, commercial 14 per cent acid phosphate, commercial hydrated lime, CaSO_4 , NaCl, NaNO_3 , $\text{Ca}_3(\text{PO}_4)_2$, $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and CaCO_3 .

Method of Analysis.

SOILS.

Loss on ignition—official method, U. S. Dept. Agr. Bur. Chem. Bul. No. 107, rev.

Total Nitrogen—official method.

Total mineral elements—sodium peroxide fusion and official methods for separations.

Soluble mineral elements—solution made by provisional method for the more active forms of phosphoric acid in soils. Official methods used for separations.

Soil Extracts.

Chlorine, carbonates, nitrates—determined by methods given in U. S. Dept. Agr. Bur. Soils, Bul. No. 31. Carbonates were estimated also by Seyler's method for natural waters. Volumetric Analysis—Sutton, p. 100 and results reported in this paper as fixed carbon dioxide.

Silica—on 300 c.c. of solution by Official Method, except soluble residues were taken up by nitric acid in place of hydrochloric acid.

Iron, aluminum and phosphorus collectively, calcium and magnesium—determined after silica by treating the solutions with excess of sodium and potassium carbonates, evaporating to dryness and igniting to destroy organic matter. Separations were then made according to official methods. Iron and phosphorus determinations were made first and when phosphorus pentoxide exceeded in quantity the iron oxide a measured excess of a standardized solution of ferric chloride was added to precipitate all the phosphorus, and the requisite correction made. The calcium oxalate was titrated by potassium permanganate.

Sulfur and phosphorus—200 c.c. of original solution was concentrated, treated with excess of sodium and potassium carbonates, evaporated, ignited at low temperature, taken up with dilute hydrochloric acid, and sulfur estimated by the official method. The solution was then neutralized by potassium carbonate, acidified with nitric acid and the official method used to determine phosphorus.

Iron oxide, potassium and sodium—300 c.c. of original solution evaporated treated with concentrated sulfuric acid, evaporated and ignited. This process was repeated until residues were quite white. Residues were dissolved in hydrochloric acid, filtered, iron, etc., precipitated by ammonia and the iron estimated by the permanganate volumetric method. The filtrate was then cleared by the usual methods and sodium and potassium weighed as sulfates; then dissolved, changed to chloride with barium chloride, excess of barium removed, and separation of the chlorides effected by platinic chloride according to the official method.

Aluminum oxid—estimated from iron, aluminum, and phosphorus oxides by differences.

Data and Discussions.

TABLE 1.—CHEMICAL ANALYSES OF THE SOILS.

(Results expressed as pounds per 2,000,000 pounds of soil.)

	No. 1.	No. 2.	No. 3.	No. 4.
Loss on ignition.....	67,209	89,200	24,600	54,400
Total nitrogen.....	2,492	3,756	1,064	2,352
Total phosphorus.....	903	1,169	814	718
Total potassium.....	29,470	26,472	17,564	27,534
Total calcium.....	14,245	13,658	8,970	10,727
Total magnesium.....	2,641	2,421	1,934	2,435
Total iron oxid.....	83,391	50,887	65,721	55,866
Total aluminum oxid.....	120,501	129,846	110,245	121,890
Total sulfur.....	621	1,166	613	956
Soluble phosphorus.....	39	89	146	181
Soluble potassium.....	362	348	108	389
Soluble calcium.....	6,320	5,101	1,453	2,652
Soluble iron oxid.....	2,666	3,268	2,706	2,403
Soluble aluminum oxid.....	3,220	4,062	1,916	3,294
Soluble silica.....	1,330	1,490	590	730
Reaction (litmus paper).....	Alkaline	Alkaline	Acid	Acid
Lime requirement (Veitch, CaO).....			1,320	1,560

TABLE 2.—QUANTITIES OF SILICA IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.
(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phos- phate.	Hydrated lime.	CaSO ₄	NaCl.	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.....	10.6	20.7	22.3	7.7	15.2	18.3	14.4	15.0	35.3	11.7
2a.....	14.0	18.5	21.8	7.0	16.0	19.4	8.2	19.0	29.0	15.3
3a.....	14.2	16.3	13.7	6.0	9.7	13.7	14.2	11.3	20.7	9.3
4a.....	12.2	15.5	12.8	6.4	10.2	12.4	11.5	12.0	22.0	10.3
1b.....	27.9	13.2	21.2	6.7	14.2	12.4	12.5	12.3	16.7	12.3
2b.....	26.0	16.2	22.2	7.7	16.5	13.0	10.0	14.7	21.3	13.0
3b.....	11.0	11.0	11.7	5.8	7.4	8.0	7.3	9.7	10.7	10.3
4b.....	11.0	10.2	13.0	8.7	8.4	8.3	8.7	10.0	12.0	10.7

The SiO₂ of the alkaline soils appears to be more soluble than that of the acid soils. That N/5 HCl also dissolves more SiO₂ from alkaline than from acid soils is shown in Table 1, and in a previous publication, Spurway (30). Other significant points in respect to SiO₂ are, hydrated lime greatly depresses its solubility, and the solubility of this component is increased by soluble phosphates. All the other treatments with but few exceptions tend to depress the solubility of SiO₂ in these soils.

TABLE 3.—QUANTITIES OF PHOSPHORIC ACID IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.
(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phos- phate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.....	.77	1.85	6.33	4.0	.93	1.40	6.87	53.71	72.54	1.78
2a.....	.93	1.62	7.72	19.8	1.51	2.72	4.86	41.21	56.02	1.85
3a.....	.77	2.05	7.43	3.24	1.26	9.03	13.04	40.75	105.57	1.54
4a.....	.31	.93	7.59	3.86	1.10	3.94	6.72	55.71	111.90	2.08
1b.....	1.32	1.62	3.69	8.20	.97	2.63	8.50	10.96	10.2	1.71
2b.....	1.16	1.70	3.47	7.30	1.04	3.13	11.50	10.19	9.0	2.01
3b.....	1.09	3.78	8.11	6.60	2.18	5.64	5.40	10.50	15.7	1.54
4b.....	.89	4.33	4.16	3.90	1.52	6.71	4.78	14.20	13.4	2.32

Table 3 shows some remarkable results. All the treatments, excepting CaSO₄ on soils No. 1 and 2, second leachings, greatly increased the quantities of P found in the soil extracts. Of the non-phosphate treatments NaNO₃ heads the list in efficiency followed in order generally by hydrated lime, NaCl, KCl, CaCO₃ and CaSO₄. Considerable variation exists between individual results which may indicate different forms or conditions of P in the soils. KCl and NaCl liberated more P from the acid than the alkaline soils, while the reverse is true for hydrated lime. The acid soils did not retain as much P from Ca(H₂PO₄)₂ as did the alkaline soils. It is also remarkable that in five cases out of the eight NaNO₃ treated soils gave up more P to the extract than when treated with acid phosphate. No apparent relationship exists between these results and the total P or that soluble in N/5 HCl as given in Table 1.

TABLE 4.—QUANTITIES OF SULPHUR TRIOXIDE IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.
(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phos- phate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.....	20.4	17.7	266.2	42.9	425.6	23.9	29.5	30.0	33.8	30.2
2a.....	14.6	16.8	268.2	39.8	436.2	19.7	25.4	34.0	29.7	29.7
3a.....	16.4	10.0	257.6	20.9	449.5	7.6	23.3	21.4	19.9	18.3
4a.....	13.6	11.0	259.2	19.1	438.6	9.2	20.4	22.8	18.9	19.0
1b.....	4.4	5.5	4.8	9.6	18.2	5.1	12.4	11.1	12.2	9.9
2b.....	4.0	5.2	4.1	10.3	21.0	1.3	10.2	8.4	9.6	7.2
3b.....	3.0	3.6	3.2	4.3	6.5	5.2	8.6	9.3	6.4	8.4
4b.....	3.0	4.2	2.9	5.1	7.1	6.1	9.8	8.6	7.3	6.5

These results show that S compounds soluble in water under conditions of the experiment are quite completely removed in the first leachings, even when CaSO₄ is added to the soils, however, not all of the S is reclaimed in the two leachings. This is also true of Cl and NO₃ added in salts. Sulfates appear to be more easily removed from acid than from alkaline soils.

TABLE 5.—QUANTITIES OF CHLORINE IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.
(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phos- phate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.	11.2	429.8	33.8	11.2	14.9	545.4	14.3	11.2	12.8	5.6
2a.	15.0	438.8	28.4	14.4	19.9	537.3	9.6	8.0	14.4	7.2
3a.	6.4	445.0	17.6	14.9	8.5	498.2	5.9	6.4	11.2	4.5
4a.	6.4	459.0	14.9	20.3	10.7	518.4	4.6	9.6	14.4	4.8
1b.	9.4	21.6	10.8	7.2	7.8	18.1	4.0	4.8	8.9	10.1
2b.	11.0	16.2	8.1	8.0	17.1	27.7	4.7	6.4	10.7	14.1
3b.	6.3	19.8	8.8	6.0	6.4	12.8	3.5	6.4	7.7	5.6
4b.	5.5	8.1	9.5	11.0	5.7	10.7	3.0	5.6	6.2	6.7

Soluble chlorides added to soils give up most of their Cl to extracts which is quite readily removed by leaching.

TABLE 6.—QUANTITIES OF CALCIUM IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.
(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phos- phate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.	20.1	148.8	109.1	57.9	185.8	83.0	54.6	54.0	57.2	79.1
2a.	34.8	172.0	129.1	84.9	202.2	134.4	69.3	75.2	30.9	77.2
3a.	26.1	146.1	128.4	68.6	211.4	90.4	68.4	57.3	38.6	92.6
4a.	12.4	108.1	99.3	62.1	181.6	63.6	41.7	39.9	30.9	103.6
1b.	33.6	21.3	78.4	75.3	32.0	20.0	27.7	56.0	59.8	101.0
2b.	74.8	85.3	160.6	118.4	78.0	73.2	79.7	99.7	132.5	162.7
3b.	45.4	24.2	82.2	80.6	49.1	20.6	22.5	81.1	65.0	101.0
4b.	30.1	14.1	56.2	70.9	26.9	12.4	12.9	39.2	48.9	83.0

KCl, NaCl and NaNO₃ increased the quantities of Ca going into solution in the first leachings and also in the second leachings on soil No. 2. That these Ca compounds are quite soluble and readily leached from the soils is shown by the fact that the quantities of Ca in extracts from the second leachings on soils Nos. 1, 2 and 4 contain less Ca than the Checks. Although the alkaline soils contain more total and acid soluble Ca than the acid soils, the quantities removed under conditions of the experiment from the acid soils by these salts are in general not much less and in a few individual instances greater than those taken from the alkaline soils. Except in one instance the CaCO₃ treatment gave more Ca in the extract than did the hydrated lime treatment; and in the first leachings from this treatment more Ca was found in the acid than alkaline soil extracts.

TABLE 7.—QUANTITIES OF MAGNESIUM IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.

(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phosphate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.....	5.1	25.7	22.4	24.1	23.5	17.7	15.1	5.4	17.4	18.2
2a.....	6.8	29.9	23.7	28.8	30.0	23.2	17.1	8.5	11.0	17.6
3a.....	4.6	16.6	14.0	24.7	16.5	13.0	8.3	4.5	11.3	16.2
4a.....	4.2	23.8	21.8	31.3	24.2	20.9	7.6	4.4	11.5	23.2
1b.....	11.8	7.0	11.4	37.3	8.3	5.7	6.5	10.5	15.9	15.2
2b.....	12.6	16.4	22.1	33.2	15.1	11.8	12.8	15.0	26.3	26.0
3b.....	8.4	7.5	9.0	33.3	6.2	3.7	3.6	15.4	11.1	18.2
4b.....	9.4	6.3	11.6	41.4	6.2	2.3	4.0	12.8	14.8	17.3

All the treatments increased the quantities of Mg in the extracts from the first leachings except Ca₃(PO₄)₂ which showed little change. Results from the second leachings vary considerably and may be influenced somewhat by Mg in the acid phosphate, hydrated lime, and CaCO₃. The phosphates were not examined for Mg.

TABLE 8.—QUANTITIES OF SODIUM IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.

(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phosphate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.....	7.7	21.9	12.0	9.7	15.8	234.7	171.6	4.7	15.0	12.4
2a.....	5.4	18.0	10.7	14.2	17.8	295.7	137.3	7.2	19.0	18.7
3a.....	9.1	13.3	6.9	9.1	9.5	250.7	199.2	4.6	9.9	12.1
4a.....	6.4	25.0	8.4	11.9	8.9	258.2	189.6	4.3	11.3	12.8
1b.....	5.5	12.0	9.9	12.4	5.6	62.8	56.0	9.7	11.9	12.2
2b.....	6.5	11.1	11.9	13.3	8.2	97.1	73.7	14.3	13.7	16.9
3b.....	5.8	18.4	11.1	10.1	5.3	55.4	45.0	16.5	9.6	10.7
4b.....	5.1	17.7	11.7	8.8	5.9	54.4	47.6	13.1	11.7	11.4

Extracts from the treated soils contain more Na than those from the checks excepting soil No. 3b with CaSO₄ treatment, and the first leachings on soils Nos. 1, 3 and 4. It is remarkable that the result on Na and Mg from the Ca₃(PO₄)₂ treatments closely correlate. Considerable quantities of Na are reclaimed in the second leachings from the NaCl and NaNO₃ treatments, indicating a continued solubility of this element.

TABLE 9.—QUANTITIES OF POTASSIUM IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.

(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phosphate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.....	9.1	145.2	8.2	7.4	11.3	12.4	8.8	7.4	8.5	7.7
2a.....	14.4	132.2	13.0	5.9	16.3	13.9	11.7	6.4	10.5	11.0
3a.....	16.0	198.1	13.2	15.8	15.0	11.1	12.5	5.2	10.1	9.9
4a.....	18.0	292.3	15.0	18.8	18.2	13.0	11.6	4.8	10.7	8.4
1b.....	13.8	100.7	11.3	9.0	10.5	10.0	4.1	3.7	7.9	6.1
2b.....	18.4	100.6	16.2	9.4	11.5	12.5	7.2	5.1	11.3	11.1
3b.....	15.4	48.5	12.3	10.3	7.2	5.3	7.3	6.8	8.8	8.9
4b.....	14.8	40.5	15.5	13.9	8.6	5.5	5.3	4.6	9.9	9.3

Except in case of KCl the tendency of the treatments was to depress the solubility of K, $\text{Ca}_3(\text{PO}_4)_2$ and CaCO_3 showing the greatest effect. Slight increases may be observed in case of the CaSO_4 treatment on soils Nos. 1a, 2a, and 4a, and the hydrated lime treatment on soil No. 4a, but they are so small as to be practically negligible. The solubility of K from the KCl treatment is continued in appreciable quantities in the second leachings.

TABLE 10.—QUANTITIES OF IRON OXID IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.
(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phosphate.	Hydrated lime.	CaSO_4	NaCl	NaNO_3	$\text{Ca}_3(\text{PO}_4)_2$	$\text{Ca}(\text{H}_2\text{PO}_4)_2$	CaCO_3
1a.....	2.9	5.0	4.8	3.1	4.8	12.6	4.5	1.9	15.5	4.6
2a.....	3.6	5.4	3.4	3.6	3.0	11.2	4.1	2.4	23.3	3.6
3a.....	2.2	8.0	2.1	5.0	1.4	7.2	2.1	2.2	19.4	2.6
4a.....	3.5	7.5	3.0	6.1	1.3	5.4	2.4	2.6	15.5	3.6
1b.....	7.0	3.2	22.9	10.1	8.8	8.0	12.7	17.2	27.3	29.3
2b.....	12.0	8.5	24.2	12.6	17.5	14.4	19.2	19.5	13.9	34.5
3b.....	2.4	3.5	12.9	8.5	7.5	4.9	7.9	14.9	20.1	14.4
4b.....	4.4	3.5	17.5	13.1	5.9	4.3	6.8	15.6	19.0	20.6

Quantities of Fe in the extracts estimated at Fe_2O_3 vary considerably. However, some interesting conclusions may be drawn. $\text{Ca}(\text{H}_2\text{PO}_4)_2$ greatly increased the quantities of Fe going into solution, as did NaCl but to a lesser extent. In the second leachings from all the other treatments excepting KCl there are increased quantities of Fe. Apparently the Fe of the soils is more soluble when the soluble products of these treatments are removed; however, the time factor may apply here. The more immediate effect of KCl seems to be greater than its residuary effect.

TABLE 11.—QUANTITIES OF ALUMINUM OXID IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.
(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phosphate.	Hydrated lime.	CaSO_4	NaCl	NaNO_3	$\text{Ca}_3(\text{PO}_4)_2$	$\text{Ca}(\text{H}_2\text{PO}_4)_2$	CaCO_3
1a.....	7.5	15.0	14.3	10.6	7.9	13.9	8.3	10.6	17.0	14.3
2a.....	9.2	14.0	12.2	12.6	7.0	11.0	6.2	7.4	35.7	13.8
3a.....	7.9	5.0	3.6	14.8	6.9	15.0	6.7	6.9	73.3	12.6
4a.....	5.7	4.5	6.3	15.2	7.6	14.0	5.2	6.3	36.6	13.6
1b.....	9.9	13.7	41.1	5.4	5.0	9.9	11.7	25.1	36.5	48.3
2b.....	10.9	29.5	45.2	6.6	13.8	16.3	14.5	22.6	26.8	19.5
3b.....	8.8	15.3	20.5	4.1	17.9	6.6	7.4	21.9	32.9	18.8
4b.....	13.2	17.9	35.3	6.5	17.0	6.5	15.4	18.9	35.9	32.4

The general tendency of all the treatments was to increase the quantities of soluble Al in the soils. $\text{Ca}(\text{H}_2\text{PO}_4)_2$, CaCO_3 and acid phosphate having the greatest effect. The effect of hydrated lime was to increase the amounts of Al in the first leachings and to decrease them in the second leachings, while CaSO_4 , NaNO_3 , and $\text{Ca}_3(\text{PO}_4)_2$ lend to the opposite effect.

TABLE 12.—QUANTITIES OF FIXED CARBON DIOXIDE IN SOIL EXTRACTS IN PARTS PER MILLION ON SOILS.

(a) 1st leachings—2 day period.

(b) 2nd leachings—15 day period.

Soils.	Check.	KCl.	Acid phos- phate.	Hydrated lime.	CaSO ₄	NaCl	NaNO ₃	Ca ₃ (PO ₄) ₂	Ca(H ₂ PO ₄) ₂	CaCO ₃
1a.....	13.2	6.2	2.4	37.2	2.4	5.4	7.8	10.8	2.4	60.6
2a.....	42.0	31.8	24.0	60.6	31.8	39.6	39.6	34.2	31.8	76.8
3a.....	24.0	20.0	10.8	52.8	13.2	20.8	21.0	21.4	21.0	71.4
4a.....	13.2	5.6	5.4	47.4	5.4	10.8	10.8	8.6	10.8	63.6
1b.....	13.2	37.2	45.0	100.2	50.4	52.8	54.0	47.4	58.2	97.8
2b.....	58.2	81.6	94.8	124.2	92.4	97.8	111.0	90.0	108.0	160.8
3b.....	18.6	31.8	45.0	81.6	37.2	47.4	55.2	76.8	63.6	100.2
4b.....	15.4	21.0	37.2	94.8	29.8	45.0	50.4	42.0	50.4	84.6

As might be expected, hydrated lime and CaCO₃ greatly increased the quantities of fixed CO₂ in the extracts. The other treatments show a general tendency towards reducing this compound in the first leachings but greatly increasing it in the second leachings. This remarkable situation leads to the conclusion that some of the basic elements added in the treatments may occur in the second extract as carbonates.

Quantities in parts per million in soils of NO₃ found in the extracts from first leachings after the NaNO₃ treatment are: No. 1, 557.8; No. 2, 516.2; No. 3, 578.4; No. 4, 585.5. Second leachings from this treatment gave only a trace of NO₃ in the extracts.

Residuary Effects.

The residuary effects of the several treatments as represented by analyses of the second leachings vary so much with each treatment and appear to have such a marked bearing on soil fertility and management that a full discussion of points not already given is thought best. It is not supposed that these effects would be produced in similar soils under field conditions, however, in certain respects they point to what might be expected particularly in soils subjected to considerable leaching.

K fixed in the soil from KCl gradually becomes soluble so that a soil treated with this fertilizer probably gives much more K to its solution for several years after treatment than it did previous to the treatment, but the acid soils did not give up K to the same extent as the alkaline soils. The Cl, however, will be reduced in quantity below that required to combine with the K as KCl. The KCl treatment then tends to leave the soil solution higher in content of K, Cl, P, Na, Fixed CO₂, SO₃, and Al, but lower in SiO₂, Ca, Mg, and Fe; and most of the K is in combinations other than KCl.

More soluble P was found in the acid soils than in the alkaline soils as a residuary effect of the KCl treatment. The general effect of the K and Na salts was to decrease the quantities of Ca in the second extracts below those of the checks. How soon this condition would be brought about by soil leaching would probably depend upon the quantities and combinations of the several elements in the soils. For instance, providing a soil is high in Ca content, as is soil No. 1, more KCl and a longer time would be required to reduce the Ca content below that of a check. This action is also apparent in the case of some other treatments.

In general the residuary effects of the acid phosphate treatment was to leave the soil extracts richer in all elements except K. A few exceptions occur, but evidently the reaction products, excepting SO_3 combinations, are less soluble than those from KCl and other more soluble salt treatments and not readily leached from the soils in first leachings. Quantities of Ca, fixed CO_2 and Fe and Al were notably increased over the checks.

The hydrated lime treatment gave more Ca, Mg, Na, P, SO_3 , fixed CO_2 and Fe and less SiO_2 , K, Cl, (with one exception) and Al in the second leachings than did the checks.

The residuary effects of the CaSO_4 treatment are very marked. SiO_2 and K were found in lesser amounts in the extracts than in the checks, while the quantities of Fe and Al (excepting one case), and P in the acid soils, were increased. In these instances the quantities of Mg were reduced as was the quantities of Ca in two cases, while the increases were small. It is astonishing that the Ca content of a soil extract is reduced in this manner after treatment with CaSO_4 . Less P was found in these extracts from the alkaline soils than from checks.

NaCl tends to leave the soil solutions lower in SiO_2 , Ca, Mg, K, and higher in Na, P, Cl, and fixed CO_2 , than the checks. Less Na but more P is found in the acid soil extract which coincides with the results from the KCl treatments.

NaNO_3 acts similarly to NaCl in that the quantities of SiO_2 , K, and Ca Mg (excepting soil No. 2) are decreased over the check and quantities of Na, P, Fe and fixed CO_2 notably increased.

The second leachings from the $\text{Ca}_3(\text{PO}_4)_2$ treatments with few exceptions are much higher in content of soil elements than the checks, excepting SiO_2 and K which are less. The soluble phosphate shows practically the same effects.

Practically the only marked difference between the residuary effects of the phosphates and CaCO_3 is the presence of more Ca and less P in the extracts from the CaCO_3 treatments.

It may be observed that the residuary effects of KCl, CaSO_4 , NaCl and NaNO_3 tend to reduce the quantities of Ca, Mg, SiO_2 and K (excepting the KCl treatment) in most cases, while acid phosphate, hydrated lime, $\text{Ca}_3(\text{PO}_4)_2$, $\text{Ca}(\text{HPO}_4)_2$ and CaCO_3 effect only the SiO_2 and K in this respect. In case of the first named salts it appears that some of the Ca and Mg in particular become quite soluble and if leached away the soil does not readily recuperate from the effects of the treatments and the solutions may lack sufficient of these elements for maximum plant growth. This effect would tend to lower the crop producing power of a soil low in content of soluble Ca and Mg and subject to leaching, in a comparatively short period of time. The recuperatory power of a certain soil under these treatments would probably depend upon the quantities of Ca and Mg present and up to a certain point of fertilizing salts added. On soils low in these elements it is probable that the use of these salts in fertilizers would sooner or later bring about a need for an application of lime.

In case of the second list of compounds named the recuperating power of the soils appears not to have been impaired except in respect to K. This effect is probably due to the fact that the solubility of Ca and Mg

is not increased relatively by the initial treatments and also these elements are added in some cases.

While in general the proper balance of mineral nutrients a soil should have for good crop production is at present not known, it is conceded that the nutrient element in the least available quantities in soils limits plant growth. These results tend to show that the addition of a certain salt not carrying mineral nutrients to soils may establish a better balance than formerly existed, while a different fertilizer salt may cause a wider range from the proper ratio. The proper kind and quantity of fertilizer to apply to a certain soil depends somewhat upon the total effect produced and not entirely upon the element or elements added. Increased crop yields obtained from the use of fertilizers, NaNO_3 for instance, may not be due to added N alone because this fertilizer has a marked effect on the solubility of other nutrient elements. Negative results sometimes obtained from the use of fertilizers may be due to depressed solubility of some important element which may be close to the point of becoming a limiting factor. An effect often observed in fertilizer practice is that applied chemicals give practically no results on the first crop with marked increases in yield on the following crop. From the data presented these effects may be explained on the basis that applied fertilizers may cause changes in the soil that are immediately harmful to plant growth, that is, an excess of some component combined with the acid radical of the salt added, as for instance CaCl_2 , or an organic compound; a change in soil reaction; a depression of carbonate content; or depressing the solubility of some element thereby causing it to become a limiting factor. After several months' time the soil may recuperate from these changes and give the added plant food elements an opportunity to produce beneficial effects on the crop.

Proper fertilization of a soil, therefore, is a complicated problem. When once a fertilizer is applied to a soil permanent changes are produced and an entirely different soil results. These changes should be considered before a second application of fertilizer is made to the same area if best results are to be obtained. The possibility of unbalancing the soluble plant food content of soils by the use of one fertilizing salt, as well as the need for a system of fertilization based on soil composition and effects produced upon the soil by added fertilizers and natural processes, is apparent from these results. Providing these factors were considered in field fertilization experiments it is possible that results obtained could be more fully explained and the use of fertilizers made more profitable.

GENERAL SUMMARY.

No attempt is made in this bulletin to explain by processes of deduction what takes place in soils when fertilizer salts are added to them. This subject is under investigation and data are being gathered for a coming report. Some generalizations can be made from the data at hand, however, which may have an important bearing on fertilization and soil management in general.

Processes influencing the quantities of soil constituents formed in the extracts have been discussed under the general term of solubility. To what extent the processes of true solubility, or chemical or physical reactions effect the results is not known. Effects produced by the different treatments may be direct or indirect. In this connection the work of Jensen (16) is cited which shows that decomposing organic matter increases the solubility of certain soil constituents; changes in concentration and the products of chemical or physical reactions may also effect solubilities. Unquestionably, the effects produced by soil treatments are highly complicated.

These results show, however, that the treatments taken singly or collectively have some certain well defined effects. The application of a soluble compound to soils appears to completely change the chemical composition of their extracts. These changes are in some instances profound and when some of the soluble constituents are removed the soil is left in a permanently changed condition. Another common effect of the treatments used in this investigation was to greatly increase the quantities of fixed CO_2 in extracts from second leachings; and of P in both leachings with but two exceptions in case of the CaSO_4 treatment. The general depression of the solubility of potassium has also been noted.

When KCl, CaSO_4 , NaCl and NaNO_3 were added to these soils, both radicals of each salt appeared in the extracts in large quantities, with the acid radical always in excess of the basic. The acid radical is apparently principally in an easily soluble combination because it is found only in small amounts in the second leachings, and the greater portion of that added to the soils is found in the first extracts, but considerable quantities of both radicals of all treatments are not reclaimed. This tendency is not observable in case of CaCO_3 and the phosphates, the extracts being enriched by each radical in approximately equivalent quantities. Other basic ions go into solution as an effect of these treatments, particularly Ca and Mg, and are readily washed from the soils. A marked effect of the phosphate and CaCO_3 treatment was to increase the total quantities of Fe and Al in the extracts.

The soils were alkaline to litmus paper after treatment with hydrated lime and CaCO_3 and leaching. All the other treatments left the soils acid to litmus paper. These results also support the conclusion that the neutral salts and phosphorus compounds used in this research destroy the carbonates of the soils thereby changing the hydrolytic equilibrium towards the acid side; that is, either causing the soils to more nearly approach an acid condition or become acid or to increase in acidity.

Summary.

Data are presented to show the effects of additions of KCl, acid phosphate, hydrated lime, CaSO_4 , NaCl, NaNO_3 , $\text{Ca}_3(\text{PO}_4)_2$, $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and CaCO_3 to two alkaline and two acid sandy loam soils on the composition of their water extracts. 1 gm. of each treatment was added to 1 kg. of soil, the soil saturated with distilled water and leached with 3 l. of water in 500 c.c. portions after standing two days. A second leaching was made after another period of fifteen days. Both extracts were then analyzed. The more prominent results are summarized as follows:

1. In general the SiO_2 of the alkaline soils was found to be more soluble than that of the acid soils. Results for the first leachings vary but less SiO_2 was found in the second leachings from the treatments than in the checks as the rule.

2. With but two exceptions all the treatments increased the quantities of P in all the extracts.

3. The acid radicals of the salts KCl, CaSO_4 , NaCl, and NaNO_3 appeared in the first extracts in relatively greater quantities than the basic radicals, and their combinations were readily leached from the soils; the second extracts contained only small quantities of these acid radicals. This was not the case with CaCO_3 and the phosphates.

4. The basic radicals of the salts KCl, CaSO_4 , NaCl, and NaNO_3 occur in the second extracts in considerable quantities but only to a small extent in the chemical combinations added.

5. More Ca was found in the second extracts than the first in case of the hydrated lime, $\text{Ca}_3(\text{PO}_4)_2$ (except one instance), $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and CaCO_3 treatments. Excepting one case, more Ca was found in the extracts from the CaCO_3 treatments than the hydrated lime treatments.

6. All the treatments excepting $\text{Ca}_3(\text{PO}_4)_2$ increased the quantities of Mg in the first extracts, as did treatments of hydrated lime, $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and CaCO_3 in the second extracts. Other Mg results vary considerably.

7. KCl, $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and CaCO_3 increased the quantities of Na found in all the extracts. A considerable variation is noted in case of the other treatments.

8. The general effect of the treatments other than KCl was to depress the quantities of K in the extracts.

9. Quantities of Fe and Al were markedly increased in the second extracts by the phosphates, CaCO_3 , NaNO_3 and CaSO_4 . $\text{Ca}(\text{H}_2\text{PO}_4)_2$ increased the Fe and Al in the first extracts, and Al was also increased in these portions by hydrated lime, NaCl, and CaCO_3 .

10. The quantities of fixed CO_2 were in general reduced in the first extracts, except in case of the hydrated lime and CaCO_3 treatments, while this component was markedly increased in the second extracts by all treatments.

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THE USE OF SOLUTIONS OF AMMONIUM CITRATE FOR THE ESTIMATION OF REVERTED CALCIUM PHOSPHATE.

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BY C. S. ROBINSON.

The use of a solution of ammonium citrate for the estimation of reverted phosphoric acid was first proposed by Fresenius, Neubauer and Luck (16)¹ in 1871 after an investigation of the value of several solutions as differential solvents for the calcium phosphates found in superphosphate. The evidence submitted by them is scarcely sufficient to warrant the elevation of their method to the important position which it now occupies, but in spite of this and the fact that subsequent research has demonstrated conclusively that it is far from perfect, their procedure has been translated and handed down, with but minor changes, through succeeding decades, to assume an almost unchallenged place in our present methods of analysis.

Although the statement was made that under the conditions as first recommended only a small and quite constant amount of tricalcium phosphate was dissolved while all of the dicalcium phosphate was removed, the experimental work was anything but conclusive and it has since been found that neither contention was unqualifiedly true. In other words it soon became apparent that a clean-cut separation of the di- and tricalcium phosphates was not afforded and thus strictly speaking, the whole procedure was reduced to the rank of an arbitrary one yielding results which were solely of relative value and that only when the conditions of analysis were rigidly fixed and consistently adhered to.

The results obtainable being determined not by the process itself but by the conditions under which it was carried out, deviations in procedure soon began to be proposed as the whims of analysts suggested changes in this or that respect. It was found that variations in temperature and time of digestion, the relative quantities of sample and reagent and the concentration and reaction of the reagent caused a diversity of results with a corresponding confusion as to the actual value of the method. Finally however all of these factors became standardized except those connected with the reagent itself. Subsequent investigation and discussion in regard to this last factor have centered largely about the following points which will be taken up in order in the present work:

¹Figures in parenthesis refer to the bibliography at the end of the publication.

I. THE PREPARATION OF AMMONIUM CITRATE SOLUTIONS HAVING A DEFINITE REACTION OR COMPOSITION.

- a. Truly neutral solutions;
- b. Solutions of triammonium citrate;
- c. Solutions of empirical composition.

II. THE RELATION BETWEEN COMPOSITION AND REACTION.

III. THE RELATION BETWEEN THE REACTION OF THE REAGENT AND ITS SOLVENT ACTION ON CALCIUM PHOSPHATES.

- a. In commercial fertilizers;
- b. In pure calcium phosphates.

I. THE PREPARATION OF AMMONIUM CITRATE SOLUTIONS HAVING A DEFINITE REACTION OR COMPOSITION.

The original description called for a neutral solution and for this reason as well as the fact that in most subsequent variations of this original procedure a neutral solution is first obtained and then made alkaline by the addition of a definite quantity of ammonia, the neutral solution has come to assume a position of paramount interest and, in fact, the means of preparing it have obscured to a large extent, the more fundamental consideration of the actual value of the method itself.

Fresenius and his colleagues make no suggestion in their original article as to their method of obtaining neutrality in their reagent. From Luck's (36) later communication it appears that such a solution was never actually obtained except perhaps by chance or but for a short time as it was being evaporated on the water bath to a density of 1.09 after being saturated with ammonia. In view of these facts as well as of the state of development of the more accurate methods of physical chemistry, it seems safe to assume that the neutrality of the solution, if it was determined at all, was tested by some indicator, probably litmus, used in the ordinary way. In the light of subsequent experience it may be concluded with equal certainty that the "vollkommen neutralen Lösung" of Luck was only approximate at best.

Its preparation promptly gave trouble, judging from statements in the literature. Herzfeld and Feuerlein (26) claimed that it was impossible to get a neutral solution with litmus. Rosolic acid gave better results but they prepared their reagent by adding to an aqueous solution of citric acid an excess of ammonium carbonate, and allowing it to stand for an hour with frequent stirring after which it was diluted to a

density of 1.105. They claimed that such a solution was neutral to litmus.

The A. O. A. C. (3) adopted a method in 1885 calling for the neutralization of the bulk of the citric acid with solid ammonium carbonate, the final adjustment being made with ammonia and testing with delicate red and blue litmus paper.

Richardson (44) reported to the Association the results of his studies of several indicators used for this purpose including coralline, cochineal and litmus paper. He said: "From the results I was led to conclude that coralline and litmus paper, carefully prepared by the method given by Sutton, and immersed in the citrate solution, are the only indicators available for determining neutrality of citrate of ammonia with a decided preference for the coralline."

Direks and Werenskiold (14) discussed at length the difficulty in obtaining a neutral solution and selected rosolic acid as being preferable to litmus as an indicator for this purpose.

Huston (29) some years later studied the question and proposed the alcoholic calcium chloride method which was adopted by the Association. At the same time Cooke (12) suggested the preparation of a solution of the normal salt by analysis. He found such a solution to be alkaline.

In 1896 Lord (35) suggested a method for neutralizing the solution in question using litmus as the indicator which, as later modified by Hand (25), has also found a place in the Official Methods. This method was based on the superposition of two tubes, containing equal concentrations of litmus in an acid and alkaline solution respectively and the addition of acid or alkali to a mixture of the citrate solution and litmus until its color just matched the composite color in the two standard tubes. This method must be acknowledged to be a long step in advance towards the solution of the problem, but the unfortunate choice of an indicator which had already been shown in a practical way to be particularly unsatisfactory for the purpose in hand and whose general unreliability was later so thoroughly demonstrated by the careful studies of Walpole (51), largely vitiated the value of an otherwise admirable procedure.

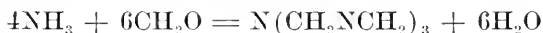
Cook (11), some time later, proposed a method which does not differ materially from that used by Herzfeld and Feuerlein. It consisted in allowing the heat of neutralization to drive off the excess ammonia.

In 1908 McCandless (37) proposed the preparation of the solution by analysis, an idea suggested some years previously by Cooke (12). According to this method citric acid is almost neutralized, the solution then being analyzed for its citric acid and ammonia content and the amount of ammonia necessary to neutralize the excess of the former calculated and added. The density of the solution is finally brought to 1.09. This method was the subject of considerable discussion during the years immediately following its proposal. In 1908, while referee on phosphoric acid, its author suggested the use of a reagent in which the ratio of ammonia to citric acid should be 1 : 3.765, this being the ratio for a solution of triammonium citrate. Subsequently the Division of Fertilizer Chemists of the American Chemical Society (1) proposed a solution in which the ratio of these ingredients should be as 1 : 4.25.

In 1911 appeared the first method based upon the electrometric ad-

justment of the solution. This was the electrical conductivity method proposed by Hall and Bell (23) and later by Patten and the author (42). It was subsequently modified by Hall (22) in an attempt to make it practicable for routine work. It depends upon the fact that upon the addition of ammonia to a solution of citric acid (or vice versa) the resistance of the solution to the passage of an electric current varies progressively till the point of complete saturation of the acid (or base) is reached, at which point, if the resistance and the amount of acid (or base) be plotted, there will be a break in the curve. It was demonstrated that accurate results could be obtained with the method but, because of the apparatus required and real or imaginary difficulties in manipulation, it has never found widespread use.

In the titration method of Patten and Marti (41) which was published in 1913 there appeared one which required neither special apparatus nor difficult technic. This method "is based upon the work of Schiff who found that ammonia unites with formaldehyde to form hexamethylenetetramine according to the following equation:



Schiff also found that the same reaction takes place between salts of ammonia and formaldehyde and that the acid may then be titrated with a standard solution of sodium or potassium hydroxide using phenolphthalein as indicator. With this method the equivalence of the acid and alkali in a solution of ammonium citrate could be easily determined and the composition of the solution adjusted accordingly."

Rudnick and Latshaw (45) used this method to prepare a solution which they compared with one prepared by a procedure devised by themselves. This was a variation of Hand's technic in which a series of solutions of varying degrees of acidity and alkalinity were prepared and that one which appeared to be the neutral one was selected for the standard. The reaction of the reagent to be used was adjusted to this using a colorimeter for their comparison. The solution prepared by the former method has a ratio of ammonia to citric acid of 1 : 3.786 and that made by the latter procedure had a ratio of 1 : 3.748.

Bell and Cowell (6) proposed two methods, one a chemical one and one a physical. The former was based upon the fact that ammonia is soluble in chloroform while citric acid and ammonium citrate are not. The solution to be tested was nearly neutralized. Aliquots were then taken and mixed with increasing quantities of standard ammonia solution. They were then shaken out with chloroform. As soon as an excess of ammonia was in the solution it could be detected in a sample of the chloroform layer removed for the purpose.

The second method proposed was based upon the determination of the point at which heat ceases to be generated by the reaction between the citric acid and ammonia.

During the same year Hildebrand's (27) article on the use of the hydrogen electrode appeared and in it he suggested the use of this apparatus for the purpose of obtaining a truly neutral solution of ammonium citrate. It was not until the following year, however, that a detailed method of procedure was published. In this second article with Eastman (15) he presented a scheme for the preparation of solu-

tions which may be either truly neutral or solutions of the "neutral" salt. The use of the latter was recommended.

McCandless (38) shortly afterwards republished his method for the preparation of a solution by analysis. He also reported the preparation of the solid salt, triammonium citrate, which when dissolved in water gave an alkaline solution gradually turning acid with loss of ammonia.

R. G. Hall (24) subsequently prepared this salt and proposed its use for the preparation of the reagent under consideration.

In his report to the A. O. A. C. in 1914, Walker (50), the associate referee on phosphoric acid, reported results comparing the titration method and the litmus method of Hand (25). He also published the results of the determination of insoluble phosphoric acid using four solutions of citrate, prepared in as many different laboratories, together with the composition of these solutions. These latter results illustrated the wide discrepancies which can and undoubtedly do arise from the use of reagents of varying composition prepared in different laboratories and demonstrated the need of a more rigid and accurate method.

Shorey (48) has lately published an account of a method of preparation of this reagent by calculating the theoretical amount of ammonia necessary to neutralize the desired quantity of citric acid.

Washburn (52) varies the usual routine of autoneutralization by drawing a current of air through his solution in order to remove the excess ammonia.

Such are the most important methods which have been proposed for gaining the desired end. It will be seen that from the very first proposal of the use of this reagent there has existed a confusion of the term neutral, as applied to the solution itself, and to the salt. This was due of course to a failure to recognize and emphasize the fact that, owing to dissociation and hydrolysis, a solution of the "neutral" or better, normal salt of ammonia and citric acid is not neutral at all but alkaline, i. e., the concentration of the hydroxyl ions exceeds that of the hydrogen ions. As it developed later the originators of the method while intending to use a solution of the normal salt actually specified a "neutral" solution. Methods subsequently offered for the preparation of the reagent reflect this confusion and naturally fall into three classes, (a) those whose sponsors attempt to prepare a truly neutral solution, i. e., one in which the concentrations of hydrogen and hydroxyl ions are equal, (b) those which give a solution of the triammonium citrate, and (c) those which yield solutions of a strictly empirical character, viz. are merely "acid" or "alkaline."

(a) *Methods for the preparation of truly neutral solutions:* In this class are all those which are adjusted by means of indicators except in the case of that of Eastman and Hildebrand (15) as hereinafter discussed. There is the serious objection to this procedure that there is no indicator which gives a sharp end-point with the acid and alkali used. Of those indicators which have been tried, rosolic acid, coralline and litmus apparently give the best results in about the order named. Yet, throughout the literature, one continually finds statements to the effect that the best is not satisfactory. From the comments of others as well as from his own experience, the writer is forced to conclude that only with the procedure devised by Lord (35) and modified by Hand (25) can anything like accurate results be obtained. This procedure

does give fairly satisfactory results. The alcoholic calcium chloride method is much its inferior, both in convenience and accuracy and possesses, in addition, certain theoretical defects which may possibly introduce significant errors. These are (1) the assumption that the acid or alkali required to produce neutrality in the solution of ammonium chloride and hydrochloric acid (or ammonium hydroxide) is the same as that required to give a neutral solution of ammonium citrate and citric acid (or ammonium hydroxide) and (2) the fact that a solution neutral to cochineal is not neutral to all other indicators nor is it neutral in the truly physical-chemical sense. This latter point has been made by McCandless (38) who also found difficulty in the use of this method.

McCandless' (37) (38) analytical method might be successfully adapted to the purpose of securing strictly neutral solutions within the limits of error of the determinations involved, could some reliable method be found for getting the composition of a truly neutral solution.

Such a method is in fact now available in the electrometric one of Hildebrand (27). By this method it is possible to prepare a neutral solution by determining electrometrically the concentrations of the hydrogen and hydroxyl ions. It necessitates apparatus and technic too involved for the average technician, which fact will probably always prevent its widespread adoption. A procedure will however be proposed later which it is believed will be exempt from some of these disadvantages.

In this same class of methods fall those whereby neutrality is sought through some means of self adjustment of the solution such as the removal of excess ammonia by heating as proposed by Herzfeld and Feuerlein (26) and Cook (11) or by aeration as suggested by Washburn (52). The fallacy of the principle of this method has been pointed out by Eastman and Hildebrand (15) and the actual uncertainty of the results obtained has been shown by McCandless (38). In such a procedure there is always danger that the removal of ammonia will not stop at the right point but will proceed beyond it and leave the solution acid, a thing which it has been claimed actually does take place in determinations made at too high temperatures with solutions initially *neutral or alkaline* unless suitable precautions are taken to prevent it.¹

(b) *Methods for the preparation of solutions of triammonium citrate:* The end sought in this class of methods is attainable by more ways than in the former one. Chronologically, McCandless' (37) analytical method was the first. By it one can, of course, prepare within the limits of accuracy of the analytical procedures involved, a solution in which the ratio of the two ingredients, citric acid and ammonia, is that in which they occur in the normal salt. There is involved neither unusual technic nor expensive apparatus such as is required for the physical chemical methods. It approximates in time and effort the preparation of any standard solution which must be checked analytically.

The various physical chemical methods, i. e., the electrical conductivity method (23) (42), the temperature method of Bell and Cowell (6), and the electrometric one of Hildebrand (27), while perhaps more or

¹Two solutions carefully prepared in this laboratory according to the directions of Cook (11) and of Washburn (52) were found to have reactions corresponding respectively to pH 5.7 and 5.5.

less economical so far as time is concerned, require apparatus not always available, and technic with which laboratory workers are not usually familiar.

In the "titration method" of Patten and Marti (41) is found one which is as adaptable to any laboratory as is McCandless' (37) (38) method and which has the advantage over that method in that it can be performed in somewhat less time. It will be discussed later in detail.

Hall (24) has suggested the use of the solid salt for the preparation of the reagent. Theoretically this scheme is above reproach and might to some degree be practically successful in the hands of men who could acquire sufficient experience in the preparation and handling of the salt. In one or two trials which we made we were unable to obtain satisfactory results, the salt always losing ammonia and yielding a solution of too high a hydrogen ion concentration. This statement should not be construed as a finally adverse criticism of Hall's suggestion. Could we have spent more time on it we could undoubtedly have checked his results, but we feel that our experience teaches conclusively that the solid normal triammonium citrate is too unstable a substance to be relied upon for use by the average laboratory worker for the preparation of the reagent in question.

Finally in this group of methods may be mentioned the colorimetric method of Eastman and Hildebrand (15). Of all those which have been proposed this one appears to be the most desirable. It is the equal of any in accuracy, requires no apparatus not found in any laboratory and the whole adjustment process can be performed with one or more titrations, depending upon the accuracy with which the operator applies the results of the first one. While the writer has certain suggestions to make whereby he thinks that this procedure may be still further improved, he nevertheless feels that in the form in which it was proposed by its originators it is superior to all others.

(c) *Methods for the preparation of solutions with empirical compositions:* This class of methods requires but little comment. Such methods are wholly empirical in nature, usually involve the securing of a neutral solution first and so far as the writer is aware occupy no place in present day methods.

In some biochemical work involving the determination of hydrogen ion concentrations the writer had occasion to make use of the methods devised by Clark and Lubs (10) for the preparation of bacterial culture media. It occurred to him that these methods could be applied equally well to the control of ammonium citrate solutions as had already been done in principle by Eastman and Hildebrand (15). The only differences between the method of the latter investigators and the one to be described are in the indicator and the standard solutions used, changes which however seem to greatly increase the accuracy and ease of manipulation of the process.

Both methods are based upon the scheme for determining colorimetrically the hydrogen ion concentrations, i. e., the reactions of solutions. In brief, this consists in preparing a series of solutions whose compositions fix their reactions which originally are determined electrometrically; adding to definite quantities of these solutions equal quantities of a suitable indicator and comparing with them the color produced by an equal concentration of the same indicator in the solution to be

tested. The basis of the method is found in the fact that indicators change color not abruptly but through a definite *range* of hydrogen ion concentration and that the range of reaction through which the change of color is observable differs for different indicators. Thus by the proper choice of indicators, any region of reaction from normal hydrogen ion concentration to normal hydroxyl ion concentration may be studied.

The choice of indicator is governed by its availability, its effective range and the vividness of its color change; the selection of the standard buffer solutions by the ease with which they can be accurately duplicated and their range of reaction.

At the time of the performance of their work, the selection of both the indicator and standard made by Eastman and Hildebrand (15) was probably the best one possible but since that time new indicators and new standards have become available which surpass in excellence those previously known.

Their technic was as follows:

"For the preparation of citrate solutions in two liter lots, dissolve 370 grams in 1500 cc. of water, and nearly neutralize with concentrated ammonia solution. Cool to 20° and then add more ammonia from a burette until a 10 cc. portion of the thoroughly stirred solution, with a suitable quantity of rosolic acid, shows the same color in a Nessler tube that the same amount of indicator gives with a 10 cc. portion of a phosphate solution prepared as follows:

Titrate a 25 cc. portion of an approximately 0.1 molar stock solution of Na_2HPO_4 (to which dilute HCl or NaOH has been added until phenolphthalin is just colorless in the solution) with $\text{N}/10$ HCl and methyl orange. To a fresh 25 cc. portion (neutral to phenolphthalin) add $1/6$ of the volume of HCl used in the previous titration. Stir well and use for the color standard above. When the citrate is neutralized, bring the solution to a specific gravity of 1.09 at 20° C."

Rosolic acid was selected after the investigation of several indicators including alizarin, guaiacum tincture, neutral red, cyanin, hematin and azolitmus. It will be seen that this method, while making use of an indicator commonly used in acidimetry, does so in a peculiar manner. Hence it cannot be grouped with the other methods utilizing this principle as was indicated above (p 7) and the general criticisms to which methods of the other type are subject cannot be applied to this one. On the other hand this method involves factors of importance which are lacking in the other. Thus rosolic acid while unsatisfactory to many when used in the ordinary fashion may be admirably suited to this new form of technic. But preferable though it may be for this purpose in comparison with the older indicators, it is quite inferior to the more recently discovered ones of the sulphonphthalin series which in their brilliancy of color and the distinctness of color changes surpass all previously known substances.

In a neutral solution $C_H = C_{OH} = 1 \times 10^{-7} = P_H 7$ where C_H represents the concentration of hydrogen ions, C_{OH} that of hydroxyl ions and P_H the symbol used by Sorensen (49) to indicate the $\log \frac{1}{C_H}$. Since Eastman and Hildebrand (15) have shown that in a solution of triammonium citrate $C_H = 1 \times 10^{-7.4}$ an indicator must be chosen whose maximum

color change occurs at approximately this point, i. e., its effective range must include a P_H range of 7.0–7.4. In the sulphonphthalin series this range is best covered by phenolsulphonphthalin or phenol red. Hence this indicator was tested as a substitute for rosolic acid to the use of which there is the very weighty objection that the reaction which is to be measured lies very close to the upper limit of its range of usefulness. It is difficult to observe a difference in the color of rosolic acid in buffer solutions of 7.4 and 7.6 when they are not placed in a series with other solutions with which a comparison serves to accentuate the differences in the colors of the individuals. And even between 7.4 and 7.8 the distinction is one of intensity rather than of character, both being pinks, the latter somewhat deeper than the former.

With phenol red, however, there is still a decided change in the *character* of the color to take place in passing towards the alkaline limit of its range. The color of this indicator at 7.6 contains much more red and decidedly less brown than at 7.4. Hence in titrating to the latter reaction any overstepping of the mark is at once indicated by the increase in the red element in the tube.

The point of weakness in the colorimeter method lies in the preparation of the standard solutions. Unless these are accurately prepared or can be checked electrometrically the results are open to question and in order that this may be avoided every precaution must be taken to secure (a) chemicals of absolute purity and of known composition and (b) to make up all solutions of them with the utmost care. To test the accuracy with which the standard solution used in the Eastman and Hildebrand method could be duplicated, four such solutions were prepared using the same sample of phosphate. They all checked the 7.4 standard of Clark and Lubs (See Table I) as closely as could be read. To 20 cc. of one of them an extra cc. of N/10 HCl was added (4.2 cc. had been added to this amount to bring its reaction to the proper point as prescribed in the directions for the preparation of the standard solution) and to the same quantity of another, one cc. of N/10 NaOH was added. In each case the reaction was changed only about 0.1 P_H . This shows that the standard is quite a reliable one when prepared according to directions. As has been pointed out by others, Na_2HPO_4 is not an ideal substance to use for this purpose. The variation in its water of crystallization makes it difficult to prepare an accurately quantitative solution but in the present case the variations resulting from this source of error would probably not be sufficient to cause any significant variations in the result obtained with it. As will be pointed out later, however, there is one source of error which should be avoided.

Several titrations of an acid ammonium citrate solution were made using this standard and rosolic acid. N/10 NH_4OH was used to titrate 10 cc. samples. 10 cc. portions of the standard solutions were taken and the proper quantities of acid and indicator added. As the addition of the ammonia solution to the samples almost doubled their volumes, water was added to the standard so that the concentration of the indicator would be approximately the same in each tube. The first two titrations were made comparing the colors with that of the standard by merely holding them in the hand. For the remaining three the comparator was used. The following amounts of N/10 NH_4OH were required:

1. 16.50	3. 9.60	5. 9.30
2. 10.15	4. 9.80	

The same solution was then titrated using phenol red as indicator and titrating to a reaction of 7.4 with Clark and Lubs standard following the technic to be described later. The following results were obtained:

1. 7.75	2. 7.80	3. 7.80
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To a 10 cc. sample of the citrate solution, 7.80 cc. of the ammonia solution were added together with the proper amount of rosolic acid and the color produced compared with that of the Eastman-Hildebrand standard previously used. The latter was found to be more alkaline than the citrate solution though both should have a P_H of 7.4. As the only difference between these standard solutions and those previously compared with Clark and Lubs standards by means of phenol red was in their having been diluted with about an equal volume of distilled water, it seemed that this must be the source of trouble. Upon preparing two solutions, one according to Eastman and Hildebrand's directions and the other in the same way but diluted as above, it was found that the latter was actually the more alkaline of the two. This experience serves to emphasize the admonition of the originators of this method that the prescribed details must be adhered to.

The figures quoted speak for themselves, however, as to the possible accuracy of the method. When a comparator is used duplicate titrations may be made which agree much better than with the litmus method. (See p. 14). Nevertheless there appears to be a small but distinct "salt effect" with rosolic acid which causes a little difference in the character of the colors in the citrate and phosphate solutions making them hard to match.

While the solution proposed by Eastman and Hildebrand answers the purpose, its use is restricted to one indicator, and admits of the preparation of solutions of but one reaction. Furthermore, there is no way of checking up its condition unless a hydrogen electrode and gas chain or a series of indicators of known reliability is available.

It is proposed to substitute for this standard one or more prepared from potassium dihydrogen phosphate and sodium hydroxide according to Clark and Lubs (10). The complete series covers a range from P_H 5.8 to P_H 8.0 in steps of 0.2. The following table shows the compositions of the various mixtures together with their reactions in terms of P_H ¹

¹JOHNS. BACT. II, p. 26.

TABLE I.
KH₂PO₄—NaOH Mixtures.

P_H				
5.8	50 cc. M/5 KH ₂ PO ₄	3.72 cc. M/5 NaOH	Dilute to 200 cc.	
6.0	50 cc. M/5 KH ₂ PO ₄	5.70 cc. M/5 NaOH	Dilute to 200 cc.	
6.2	50 cc. M/5 KH ₂ PO ₄	8.60 cc. M/5 NaOH	Dilute to 200 cc.	
6.4	50 cc. M/5 KH ₂ PO ₄	12.60 cc. M/5 NaOH	Dilute to 200 cc.	
6.6	50 cc. M/5 KH ₂ PO ₄	17.80 cc. M/5 NaOH	Dilute to 200 cc.	
6.8	50 cc. M/5 KH ₂ PO ₄	23.65 cc. M/5 NaOH	Dilute to 200 cc.	
7.0	50 cc. M/5 KH ₂ PO ₄	29.63 cc. M/5 NaOH	Dilute to 200 cc.	
7.2	50 cc. M/5 KH ₂ PO ₄	35.00 cc. M/5 NaOH	Dilute to 200 cc.	
7.4	50 cc. M/5 KH ₂ PO ₄	39.50 cc. M/5 NaOH	Dilute to 200 cc.	
7.6	50 cc. M/5 KH ₂ PO ₄	42.80 cc. M/5 NaOH	Dilute to 200 cc.	
7.8	50 cc. M/5 KH ₂ PO ₄	45.20 cc. M/5 NaOH	Dilute to 200 cc.	
8.0	50 cc. M/5 KH ₂ PO ₄	46.80 cc. M/5 NaOH	Dilute to 200 cc.	

Unless some means of checking the first solutions made from it are accessible the phosphate should be recrystallized four or five times. This product may then be kept as a special reagent for future use and the solutions made from it by carefully weighing out the desired quantities.

The sodium hydroxide solution is prepared from carbonate-free material and standardized in the usual manner. It should be kept in a paraffined bottle and protected from the carbon dioxide of the air.

From these stock reagents solutions may be repeatedly prepared having reactions so constant that no difference in color can be detected between lots made at different times. Thus once the reliability of a given stock is established, the accuracy of the results with it may be regarded as fixed.

For the purpose in hand the whole series is of course unnecessary. It is well however to prepare two extra solutions, one on either side of the one to which the unknown solution is to be compared. This permits of a check on the accuracy of the standard, whose color should be intermediate between the colors of the other two. It also allows a more accurate and rapid adjustment of the reaction of the unknown, the color of which may be roughly made to match that of one of the solutions above or below the one finally sought and then carefully brought to the ultimately desired point. If, on the other hand, the endpoint is slightly overreached in the process it may be more easily detected and the magnitude of the error approximately judged by comparison with the third solution.

In this laboratory the comparisons are made in test tubes 7x7/8 inches placed in a comparator similar to that described by Dernby and Avery. (13).

Method of procedure: The desired quantity of citric acid is dissolved in water, the solution being kept quite concentrated, and almost neutralized with concentrated ammonia. The neutralization is controlled roughly by withdrawing a few cc. of the citrate solution from time to time, diluting with water to a convenient volume mixing with the proper amount of indicator (which may be measured in drops from a dropping bottle) and comparing with a standard solution several degrees lower in reaction than the solution ultimately sought. We have found it convenient for instance to use a 6.6 or 6.8 standard when the final reaction is to be 7.0 or 7.4. When the acidity of the solution has been reduced to this point, a measured sample is transferred to a test tube with a calibrated pipette, the correct amount of indicator added, and standard ammonia solution run in from a burette, first adding the alkali rapidly until the color of the solution approximates that of the proper standard. This comparison need not be made in the comparator. The process is finally completed by carefully adding small amounts of ammonia until the color of the citrate matches perfectly that of the standard having the reaction finally sought.

During the preliminary titration the tube containing the standard solution is supported in some convenient fashion just behind that into which the ammonia is being run from the burette, a white background being arranged for both. In this way the progress of the titration may be easily controlled and followed almost up to the final endpoint. The final adjustment is however made by means of the comparator, after bringing the volume of the citrate solution up to that of the standard.

From the results of this titration, the amount of ammonia necessary to bring the whole volume of the acid citrate solution up to the same reaction can be calculated. After the addition of the calculated quantity to the bulk of the solution its reaction is checked by transferring a few cc. to a test tube, diluting to the same volume as that of the standard and comparing their colors after the addition of the proper quantity of indicator. If they check, the density of the solution is brought to 1.09 at 20° and if desired, the reaction again checked.

It is a well known fact which has already been referred to in this article that the hydrogen ion concentration of a solution is altered by its dilution, the extent of the change depending on several factors. A number of tests demonstrated, however, that ammonium citrate solutions of the concentrations met with may be diluted at least five times without undergoing a noticeable change in reaction. We have never been able, for instance, to detect a change in the reaction of a solution which had been adjusted as outlined above, upon diluting it to the required density of 1.09, though the test was always repeated after this dilution.

The accuracy with which duplicate titrations may be made is shown by the following results. A solution of ammonium citrate was prepared having a reaction corresponding to a P_H of 6.7. Three 10 cc. samples, titrated independently i. e. without observing the burette until after the end of each operation, required respectively 12.65, 12.68 and 12.68 cc. $N/10$ NH_4OH to give a reaction of 7.4.

A similar experiment with another solution gave values of 6.32, 6.32 and 6.37 cc. $N/10$ NH_4OH to raise the reaction of a 10 cc. sample to a P_H of 7.0.

When an attempt was made to use a sample of litmus of unknown origin and Hand's technic, no difference in tint could be observed between the sample and the standard neutral color, though there was a very decided difference with phenol red between the color of this solution and the Clark and Lubs standard with a P_H of 7.0. Upon substituting some Kahlbaum's "A1" litmus for that used above, the following figures were obtained for as many successive and independent titrations with 10 cc. samples:

- | | |
|-----------------------------|-----------------------------|
| 1. 4.17 cc. $N/10$ NH_4OH | 5. 5.32 cc. $N/10$ NH_4OH |
| 2. 4.67 cc. $N/10$ NH_4OH | 6. 3.87 cc. $N/10$ NH_4OH |
| 3. 3.82 cc. $N/10$ NH_4OH | 7. 3.27 cc. $N/10$ NH_4OH |
| 4. 4.72 cc. $N/10$ NH_4OH | |

The results with Kahlbaums azolitmin were no better:

- | | |
|-----------------------------|-----------------------------|
| 1. 4.70 cc. $N/10$ NH_4OH | 5. 3.63 cc. $N/10$ NH_4OH |
| 2. 5.00 cc. $N/10$ NH_4OH | 6. 3.07 cc. $N/10$ NH_4OH |
| 3. 4.00 cc. $N/10$ NH_4OH | 7. 3.42 cc. $N/10$ NH_4OH |
| 4. 4.00 cc. $N/10$ NH_4OH | |

It was difficult to get a perfect match with the two sets of tubes and the color change upon the addition of a small quantity of the alkali was insignificant.

Using Clark and Lubs standards, azolitmin as indicator and the technic described for the use of phenol red, somewhat better results were obtained.

Azolitmin as an indicator for this purpose is however much inferior to phenol red, occupying an intermediate position between coralline, which is poorer, and rosolic acid which is somewhat better.

In all of the above work it will be observed that N/10 NH_4OH was used whereas in previous investigations it has been customary to work with much stronger solutions such as N/5 or N/2 with a corresponding diminution of the sensitiveness.

II. THE RELATION BETWEEN COMPOSITION AND REACTION.

The use of McCandless' method (36) (37) of preparing the reagent has been restricted to the preparation of the solution of the normal salt because in this solution alone is the ratio of ammonia to citric acid definitely fixed. In such a solution the ratio $\text{NH}_3 : \text{C}_6\text{H}_8\text{O}_7$ is 1 : 3.766. Attempts have been made to fix the composition of a truly neutral solution but without much success and as Hand pointed out, "any analytical method in a large measure leaves the question in its former condition, because we must first prepare the neutral solution before we can ascertain the precise amounts of citric acid and of ammonia that will reproduce it."¹

McCandless (37) acting in accordance with instructions of the A. O. A. C. attempted to determine the relation between the reaction and compositions of several solutions sent to him by testing them for neutrality to coralline and also determining the ratios of ammonia to citric acid in them. Of nine solutions submitted, three proved to be neutral to the indicator used. The ratios in these three were respectively 1 : 3.803, 1 : 3.816 and 1 : 3.808, giving an average of 1 : 3.809.

A solution prepared by Rudnick and Latshaw (45) and carefully neutralized to litmus had a ratio of 1 : 3.748.

The development of the methods for determining the concentration of hydrogen ions in solutions gave us the first method for accurately preparing a truly neutral solution the determination of whose composition would serve for its reproduction. Using the colorimetric method outlined above but with some variations in technique we prepared and analyzed a number of such neutral solutions. The actual procedure used in their preparation was as follows:

One hundred ten gram portions of citric acid were weighed into 700 c.c. flasks, each dissolved in 75 c.c. of water and mixed with concentrated ammonia to bring the reaction up to 6.6-6.8. For the final neutralization, each solution was transferred to a 500 c.c. graduate, diluted to a density of 1.11-1.10 and mixed with a measured quantity of indicator. The same volume of standard phosphate solution having a P_H of 7.0 was placed in a similar graduate and mixed with the same amount of indicator. 2N NH_4OH was then added to the citrate solution until its color checked that of the standard solution whose volume was equalized with distilled water. The reaction was finally checked by removing a few c.c. of the citrate, diluting and checking against some of the standard in the comparator. The neutralized solutions were then returned

¹Bull. 132, Bur. of Chem. p. 9.

to the flasks and their densities adjusted to 1.0900 ± 0.0001 at $20^\circ \pm 0.5$ using a pycnometer.

For analysis, 25 c.c. samples were diluted to 250 c.c. and 10 c.c. aliquots used for the determinations. The ammonia was estimated by the distillation method and the citric acid by titration after the addition of formaldehyde, all determinations being made in triplicate. The averages are given in the following table:

TABLE II.

Sol.	Grams NH_3 per L.	Grams $\text{C}_6\text{H}_8\text{O}_7$ per L.	Ratio.	
			$\text{NH}_3 : \text{C}_6\text{H}_8\text{O}_7$	
1.....	45.39	171.83	1 :	3.785
2.....	45.36	172.66	1 :	3.807
3.....	45.37	172.02	1 :	3.791
4.....	45.35	171.96	1 :	3.791
5.....	44.90	171.06	1 :	3.809
6.....	45.39	171.70	1 :	3.783
7.....	45.68	173.05	1 :	3.788
8.....	45.20	171.70	1 :	3.798
Average.....	45.33	172.00	1 :	3.794

*Neutralized by ordinary technic. See p. 13.

While such differences may appear to be large, it should be stated that the extreme readings for the whole series were 26.41 and 26.87 c.c. N/10 HCl for the ammonia determinations and 26.72 and 27.03 c.c. N/10 NaOH for the citric acid estimations. A "neutral" solution of ammonium citrate may then be defined as one in which the ratio of $\text{NH}_3 : \text{C}_6\text{H}_8\text{O}_7$ is 1 : 3.794. At 20° such a solution containing 45.33 g. NH_3 and 172.00 g. $\text{C}_6\text{H}_8\text{O}_7$ per liter will have a density of 1.09.

Of the solutions analyzed by McCandless the three which were neutral to coralline were actually very close to the point of absolute neutrality, much closer in fact than the one which he selected as a standard. Here again however is a case of the confusion of the two solutions, one neutral itself in reaction and the other a solution of the neutral salt.

Four solutions of ammonium citrate were next made and carefully adjusted to a S. G. of 1.09 and reactions respectively of 6.6, 7.0, 7.4 and 7.8. The indicators used for the adjustment of the reaction of these solutions were brom thymol blue for the first, phenol red for the second and third and cresol red for the fourth. The last one could not be held constant for any length of time because of loss of ammonia. It was however always within 0.05 P_H of the indicated value. Their compositions are given in the following table:

TABLE III.

Sol.	P_H	Grams NH_3 per L.	Grams $\text{C}_6\text{H}_8\text{O}_7$ per L.	Ratio. 4	
				$\text{NH}_3 : \text{C}_6\text{H}_8\text{O}_7$	
A.....	6.6	44.83	174.39	1 :	3.890
B.....	7.0	45.20	171.20	1 :	3.798
C.....	7.4	45.15	170.10	1 :	3.767
D.....	7.8 —	45.54	170.55	1 :	3.745

Theoretically, Solution C should have a ratio of 1 : 3.765 and according to the results of Hand (25) and of Patten and Marti (41) a somewhat larger content of ammonia and of citric acid for the specified density. According to Hand the sum of these two constituents should amount to 213.06 g. per liter, while Patten and Marti found 213.33 g. per liter instead of 215.35. This is an agreement of one per cent which is probably as close as most solutions made for this purpose would check.

A committee appointed for the purpose of investigating this matter by the Division of Fertilizer Chemists of the American Chemical Society (1) prepared and analyzed three supposedly neutral solutions. Their results are expressed in grams of "Crystallized" citric acid per liter and their recommendation reads, "Standard ammonium citrate solution shall contain 186 g. crystallized citric acid and 43.7 g. ammonia per liter, measured at 20°," etc. This has been interpreted by subsequent critics as referring to the anhydrous citric acid in which case the ratio of ammonia to citric acid would be 1:4.256. Such a solution would, in the light of the above results be extremely acid. When it is considered however that "crystallized" citric acid contains one molecule of water of crystallization and the above figures are altered to conform to those of other investigators the amount specified for use becomes 170.9 g. and the ratio $\text{NH}_3 : \text{C}_6\text{H}_8\text{O}_7$, 1 : 3.911. Even this is of course too high and would give an acid solution with a P_H somewhat below that of Solution "A."

III. THE RELATION BETWEEN THE REACTION OF THE REAGENT AND ITS SOLVENT ACTION ON CALCIUM PHOSPHATES.

In commercial fertilizers: The difficulty in preparing a reagent of constant reaction early led to a consideration on the part of investigators of the results of variations in this factor upon the analytical results.

Thus Antz and Erlenmeyer (2) claimed that an acid citrate solution dissolved the tricalcium salt more readily than did the neutral solution. They also claimed that the treatment of the salt i. e., whether it had been dried at a high or low temperature, altered its solubility.

Barille (5) found the same to be true when a neutral solution was used and showed that a very appreciable amount of tricalcium phosphate was dissolved by such a solution.

Dirks and Werenskiold (35) analyzed several samples of phosphatic material using a neutral solution, three solutions of varying degrees of alkalinity, Herzfeld and Feuerlein's (26) solution (also supposedly a neutral one but prepared in a particular way) and Wagner's acid solution. The last proved to be incomparable with the others. None of the alkaline solutions gave a clean separation between the two calcium phosphates involved. They found that the neutral solution dissolved the tricalcium salt appreciably but that its solubility decreased with an increase in alkalinity. Beyond a certain point in this direction,

however, the dicalcium phosphate was not completely soluble. With natural phosphates they found that mineral phosphates dissolved in ammoniacal ammonium citrate to an inappreciable extent and they go so far as to say that with superphosphate from such a source the reverted phosphoric acid may be practically completely separated from the original material by such a solution. As a result of their work they recommend the use of Peterman's solution which is an alkaline one, viz., a neutral solution having a density of 1.09 to which 50 c.c. of NH_4OH (S. G. 0.91) per liter has been added.

Gibson (17) compared the action of three solutions on calcium phosphate. One of these was prepared by the A. O. A. C. official method, i. e., was neutral, while the other two were alkaline. The last two gave concordant and constant results while with the first the figures were variable. He ascribed this to a tendency on the part of the neutral solution to become acid.

Gladding (18) found both di- and tricalcium salts completely soluble in neutral ammonium citrate solution and says, "A slightly ammoniacal citrate of ammonia solution alone of all the solutions which have been proposed, is a perfect solvent for all the forms of reverted phosphate while at the same time not unduly dissolving the raw or insoluble phosphate present."

In a later article (19), however, from the results of the analysis of 25 samples of natural phosphates using four citrate solutions of different reactions, corresponding in a qualitative way to those described on page 16 of this paper, he shows that an acid solution dissolves a greatly increased quantity of tricalcium phosphate and that an increasing alkalinity causes a decrease in the solubility of all forms of phosphate of lime. He therefore reverts to the neutral solution as the solvent of choice.

In general, his acid solution gave the lowest results for citrate-insoluble P_2O_5 (the highest for citrate-soluble which was the way they were reported) while an increase in alkalinity gave a corresponding increase in the citrate-insoluble fraction.

Bosworth (7) found that tricalcium phosphate was soluble in ammonium citrate and also emphasizes the change in reaction of the solution resulting from digestion at 65° . His results are, however, open to criticism as he removed the ammonia with a current of air.

Grupe and Tollens (20) found that while dicalcium phosphate was more easily soluble than the tricalcium salt, the latter was, nevertheless appreciably soluble in ammonium citrate.

Huston (28) claimed that generally there was but little difference in the solvent action of citrate solutions of varying reactions but that in some cases an alkaline solution dissolved much more. He found that the tricalcium phosphate of bones was soluble in ammonium citrate solution.

Joulie (31), shortly after the publication of the original description of the ammonium citrate method, proposed a strongly alkaline reagent instead of the neutral one recommended by Fresenius. Luck (36) in replying to him voiced the objection that such a solution would cause the conversion of some of the dicalcium salt into the insoluble tricalcium compound which would then not be removed and would thus cause erroneous results. This contention was subsequently supported by Olsen (40).

Patten and the author (42) reported the results of the analysis of two samples of superphosphate, using four citrate solutions of different compositions, in which there was a marked increase in the insoluble P_2O_5 with an increase in alkalinity.

Rudnick and Latshaw (45) prepared two solutions having ratios of ammonia to citric acid of 1:3.786 and 1:3.748 respectively. With these solutions, which according to our measurements would have reactions of approximately 7.2 and 7.8, they found no significant differences in the results of the analysis of one sample of phosphate.

Shepard (46) found some tricalcium salt dissolved by ammonium citrate.

Zulkowski and Cedivoda (54) claimed that dicalcium phosphate is soluble in an excess of triammonium citrate and in the theoretical amounts of mono- and diammonium citrate while tricalcium phosphate is soluble only with difficulty in a large excess of any of these solvents.

The originators of the ammonium citrate method designated that the reaction of the reagent should be neutral but the specification was not emphasized further than to emphasize the one word *neutral*. There is no discussion of the evils resulting from a deviation from this recommendation.

As a matter of fact, as pointed out above, within a short time after the publication of the original method, the use of an alkaline solution was advocated and rather widely adopted. Joulie (31) in France and Peterman (43) in Germany suggested such solutions and these acquired considerable popularity in Europe. Similar solutions were also advocated by Landrin (34) and Millot (39).¹ Very recently Eastman and Hildebrand (15) have recommended the use of a solution of the triammonium citrate as being more accurately prepared than a truly neutral solution though the former solution would be slightly alkaline. In this connection it is of some significance that Luck (36) in his acrimonious reply to Joulie (31) states that, in attempting to avoid the possibility of the solution becoming acid in the course of the digestion through the escape of ammonia and to insure the presence of the "neutral salt" the solution was, after being adjusted to a density of 1.09, brought "*to a weakly alkaline reaction with a few drops of ammonia.*" It follows from this admission that *the original Fresenius, Neubauer and Luck method involved the use, not of a neutral solution of ammonium citrate, but of a solution approximating that of the so-called "neutral" salt, i. e., the triammonium citrate, which solution would be slightly alkaline.*

To insure the solution not becoming acid during the digestion, Fresenius, Neubauer and Luck (16) further conducted the digestion at the low temperature of 35° in order to minimize the escape of ammonia. This point was later discussed by Gladding (18) and by Williams (53).

This effect of temperature is two-fold, an increase tending to increase the rate of solution and thus to permit of the more accurate estimation of the difficultly soluble phosphates of iron and aluminum but also tending to drive off ammonia and thus to give rise to an acid solution which will dissolve an undue amount of tricalcium phosphate. The method originally adopted by the A. O. A. C. called for a bath temperature of 40° attained as rapidly as possible after introducing the flask contain-

¹ Who was, however, not its originator.

ing the digestion mixture. This was later changed to a bath temperature of 65°. This decision gave rise to considerable discussion as to the exact time allowable in raising the temperature to the final maximum, the outcome of which was the adoption of a temperature inside the flask of 65°, the bath being held at such a temperature as would maintain this for 30 minutes and the temperature to be brought to this point before the introduction of the sample. To prevent the escape of ammonia it is prescribed that the flask shall be tightly stoppered.

From the above discussion it is perfectly plain that the selective solvent action of ammonium citrate is purely a relative matter. This is further confirmed by an examination of the results of experiments

P_2O_5
involving the ratio $\frac{\text{Reagent}}{\text{Reagent}}$. Herzfeld and Feuerlein (26), Gladding (18), Koenig (32), Johnson (30), and Huston (29) have all offered evidence in proof of the statement that an increase in the relative amount of solution increases the quantity of phosphoric acid removed. Since these two points are of minor importance in the present work further discussion of them will be postponed.

To more thoroughly test these points the four solutions previously described (page 16) were used for the analysis of twelve samples of commercial phosphates having citrate-insoluble fractions running from about one-half of one per cent to over ten per cent. The determinations were made in duplicate and showed good agreement. The average available P_2O_5 , together with the results obtained in the regular fertilizer inspection work, are given in Table IV.

TABLE IV.
Average Available P_2O_5 .

Sample No.	Sol. A.	Sol. B.	Sol. C.	Sol. D.	Lab. Sol.
3393.....	13.61	13.71	13.53	13.50	14.09
3356.....	15.93	15.93	15.84	15.77	15.77
3354.....	12.96	13.08	13.01	12.91	12.95
3346.....	9.15	9.22	9.21	8.95	9.21
3352.....	9.06	9.08	9.03	8.90	9.05
3230.....	15.58	15.60	15.60	15.56	15.51
3216.....	16.96	16.98	16.98	16.95	16.92
3088.....	10.65	10.31	10.21	9.80	9.94
3083.....	11.65	11.64	11.23	11.34	11.78
2871.....	9.75	9.58	9.13	8.98	8.78
2667.....	8.05	7.95	7.35	7.77	7.16
2666.....	12.35	11.70	11.68	11.75	11.65

It may be well to state that these solutions cover a range probably wide enough to include those prepared by the usual methods using ordinary care. Consequently the results represent the *practical* extremes which could be anticipated from solutions made in different laboratories or by different analysts. Two of the solutions, "B" and "C" possess particular interest in that the former is strictly neutral and the latter a solution of the triammonium citrate.

The results are of interest in that they show no large variation in the values for available P_2O_5 with variation in reaction. Those with the acid solution "A" and the neutral solution "B" are generally the

highest. With the alkaline solutions "C," "D" and "L" (the last being the laboratory solution and presumably approximating "C" in composition) there is no marked consistency, the relative values fluctuating irregularly. In the majority of cases, the differences scarcely exceed those possible from experimental error. We can conclude from these results that the choice of solution to be used in this work must be based upon considerations other than the effect of its reaction on the solubility of calcium phosphate.

This must not be construed as an argument in favor of laxity in preparing this reagent. While in the majority of cases a difference of 0.4 P_H may make no significant difference in the results, it is probable that some materials are more susceptible to the action of alkali than others and consequently, in order that uniformity of results may be assured, the specifications for the reagent must be rigidly adhered to.

This question has another phase which was alluded to by Luck (36), Eastman and Hildebrand (15), Bosworth (7) and others, namely the constancy of the reaction of the reagent during the determination. In order to get information on this point, the filtrates from the citrate digestions in the above determinations were collected separately from the washings and their reactions determined as follows:

Approximately 5 c.c. portions of the more or less highly colored filtrates were transferred to test tubes and diluted to about 20 c.c. with distilled water. In most cases this dilution served to reduce the color sufficiently to permit an accurate comparison with the standard solutions by means of the comparator. In some cases, however, it was necessary to compensate for it by placing a second tube of the sample diluted as above but without indicator, in front of the standard and one of distilled water in front of the sample. Since the standard solutions differed by intervals of 0.2 P_H the intermediate values in the tables are of course simply estimates. The results appear in the following table.

TABLE V.

Sample No.	Solution A.	Solution B.	Solution C.	Solution D.
None	6.6	7.0	7.4	7.8-
3393 a.	6.6	7.0-	7.0+	7.3
3393 b.	6.6	7.0-	7.1	7.2+
3356 a.	6.6+	7.0	7.3	7.4+
3356 b.	6.6+	7.0	7.2-	7.4+
3354 a.	6.6	7.0	7.2-	7.4-
3354 b.	6.6	7.0	7.2-	7.4
3346 a.	6.6	7.0+	7.2	7.4+
3346 b.	6.6	7.0+	7.2+	7.4+
3252 a.	6.6	7.0	7.2	7.4
3252 b.	6.6	7.0	7.2	7.4
3230 a.	6.6-	7.0-	7.1	7.2+
3230 b.	6.6-	7.0-	7.1	7.2+
3216 a.	6.5	6.8	6.9	7.2-
3216 b.	6.5	6.8	6.9	7.1
3085 a.	6.6	7.0	7.1	7.3
3085 b.	6.6	7.0	7.1	7.3
3086 a.	6.6	7.0	7.0+	7.3
3086 b.	6.6	7.0	7.1	7.3
2871 a.	6.6	7.0	7.0+	7.4-
2871 b.	6.6	7.0	7.0+	7.3
2667 a.	6.6	7.0	7.0+	7.2+
2667 b.	6.6	7.0-	7.0	7.2+
2666 a.	6.6	7.0	7.1	7.2+
2666 b.	6.6	7.0	7.1	7.2+

It will be seen that solutions "A" and "B" remain practically constant, but that the alkaline ones "C" and "D" lost enough ammonia during the digestion and subsequent filtration to reduce their P_H values approximately 0.2. It would therefore appear to be a futile procedure to adjust with great care an alkaline solution to be used in this work since its reaction changes so much during the analysis. This perhaps constitutes a rather strong argument in favor of the truly neutral solution, since this maintains its original character throughout the determination except in certain cases, one of which was met with in Sample No. 3216. This sample, it will be observed, consistently caused an increase in the acidity of the citrate solution.

These results are notably at variance with those of Bosworth (7) whose method of attacking the problem seems however to be open to criticism in that he passed a current of air over the digestion liquid. Obviously the continued removal of the air from the flask with the consequent removal of ammonia would tend to increase the extent of the dissociation of the ammonium salt and hence magnify what under the prescribed conditions of the determination evidently is a matter of small account. Even on *a priori* grounds, without the support of experiment it is difficult to conceive of a great change in the reaction of the liquid when the escape of the ammonia is reduced to the extent that it is in the procedure under discussion. In solutions C and D one would naturally expect the magnitude of this tendency to be increased but it will be observed that even in these solutions only one sample yielded an *acid* filtrate and that was unquestionably due to some acid in the sample. Hence we must conclude that the old bogie of an acid solution resulting from this procedure must be abandoned.

On pure calcium phosphates: Not only have experiments been conducted upon the action of ammonium citrate solutions on commercial fertilizers but supposedly pure di- and tricalcium phosphates have also served as materials for investigation. Considerable mention has already been made of this, and several articles from the literature referred to. Briefly, the results seem to show that an acid citrate solution attacks the tribasic salt to a much greater extent than does an alkaline one but as the alkalinity is increased the solubility of the dibasic phosphate also diminishes. Both the neutral and alkaline solutions appreciably dissolve the tricalcium as well as the dicalcium salt and hence do not give a clear separation of the two.

Gladding (19) as a result of his work, makes the following interesting comment:

"That artificially precipitated phosphate of lime, whether the dicalcium or tricalcium form, when mixed with sulphate of lime (as is the case in a superphosphate) and exposed to atmospheric conditions in shade in open vessels for several days, and dried to a pulverulent powder, is readily and conveniently soluble in a neutral solution of citrate of ammonia, at the temperature of 40° C."

Could the truth of this contention be conclusively demonstrated, it would give an added importance to the results obtained by the citrate method since it could be argued that the distinctive difference in the conduct of tricalcium phosphate towards ammonium citrate before its conversion into acid phosphate and after it has gone through this

process and returned to its tribasic form, might be indicative of its behavior in the soil as a source of plant food. In other words, superphosphates contain, not only dicalcic or reverted phosphate but also *available* tricalcic phosphates and unavailable raw phosphate, the two last existing as separate and distinct substances. The availability of a limited amount of the tricalcium phosphate, which has always been recognized, is thus due to an actual difference in the character of two portions of this fraction and not merely to the limited solubility of it as a whole.

It would also serve to invalidate the contention that an alkaline citrate solution might convert some soluble dicalcium phosphate into the *insoluble* tricalcium form.

In some of the previous work upon which some of the above mentioned conclusions are based, the purity of the reagents is open to question and so it was decided to reinvestigate the problem, paying special attention to this feature.

Dicalciumphosphate was prepared as follows:

Pure calcium chloride (Kahlbaum's C. P.) was dissolved in water and treated with a solution of pure disodium phosphate. According to Cameron and Seidell (8) as long as the solution is acid, the solid phase separating out is the dicalcium form. Consequently the addition was stopped while the solution was still acid, the precipitate filtered off and thoroughly washed until free from chlorides. It was analyzed for calcium and P_2O_5 with the following results:

	Theory	Found
CaO	41.19	41.60
P_2O_5	52.20	52.24

Tricalcium phosphate was prepared from pure phosphoric acid and calcium chloride. Kahlbaum's C. P. phosphorus pentoxide was dissolved in water and boiled with a little nitric acid. This solution was then treated with calcium chloride in excess. According to Cameron and Seidell the pure tricalcium salt is apparently unobtainable, the solid phase always containing too much lime. Our product, however, analyzed as follows and appeared to be the tricalcium salt:

	Theory	Found
CaO	54.21	53.98
P_2O_5	45.79	45.69

The following mixtures were prepared using the above materials, (which however contained some moisture and hence gave somewhat lower contents of P_2O_5) a sample of raw rock phosphate and pure calcium sulphate.

Sample.	Composition.	Total P_2O_5
A.....	Pure $CaHPO_4$	44.80
B.....	Pure $Ca_3(PO_4)_2$	44.35
C.....	Raw phosphate rock.....	30.45
D.....	6g. $CaHPO_4$ +12g. $CaSO_4$	15.60
E.....	6g. $Ca_3(PO_4)_2$ +12g. $CaSO_4$	16.10
F.....	6g. rock +12g. $CaSO_4$	11.05
G.....	4.5g. $CaHPO_4$ +1.5g. $Ca_3(PO_4)_2$ +12g. $CaSO_4$	15.51
H.....	3.0g. $CaHPO_4$ +3.0g. $Ca_3(PO_4)_2$ +12g. $CaSO_4$	15.65
I.....	1.5g. $CaHPO_4$ +4.5g. $Ca_3(PO_4)_2$ +12g. $CaSO_4$	15.65
J.....	4.5g. $CaHPO_4$ +1.5g. rock +12g. $CaSO_4$	14.00
K.....	3.0g. $CaHPO_4$ +3.0g. rock +12g. $CaSO_4$	13.20
L.....	1.5g. $CaHPO_4$ +4.5g. rock +12g. $CaSO_4$	12.00

These samples were analyzed in the same manner as were the commercial goods using the same four solutions. The filtrates were tested for change in reactions as were those in the previous work. The results are given in the following tables:

TABLE VI.

Sample No.	Average Available P_2O_5				Total P_2O_5
	Sol. A.	Sol. B.	Sol. C.	Sol. D.	
A.....	39.34	37.22	36.17	31.85	44.80
B.....	11.50	9.00	8.75	7.65	44.35
C.....	0.65	1.35	1.05	0.95	30.45
D.....	15.47	15.08	11.72	11.61	15.60
E.....	5.77	4.60	4.60	3.95	16.10
F.....	1.30	1.27	1.50	1.27	11.05
G.....	12.11	12.00	11.92	11.65	15.51
H.....	10.30	9.12	9.00	8.05	15.65
I.....	7.75	6.67	6.47	5.97	15.65
J.....	11.45	11.39	11.28	11.07	14.00
K.....	8.20	8.35	8.20	8.05	13.20
L.....	5.00	4.57	4.72	4.62	12.00

TABLE VII.

Sample No.	Per cent of Total P_2O_5 Available.			
	Sol. A.	Sol. B.	Sol. C.	Sol. D.
A.....	87.8	83.1	80.7	77.7
B.....	25.9	20.3	19.7	17.2
C.....	2.1	4.1	3.4	3.1
D.....	99.2	96.8	94.4	93.7
E.....	35.8	28.6	28.6	21.5
F.....	11.8	11.5	13.6	11.5
G.....	78.2	77.4	76.8	75.0
H.....	65.8	57.3	57.5	51.1
I.....	49.5	42.6	41.7	38.3
J.....	81.8	81.4	80.6	79.2
K.....	62.1	63.3	62.1	61.0
L.....	41.7	38.1	39.3	38.5

TABLE VIII.

Sample No.	Sol. A.	Sol. B.	Sol. C.	Sol. D.
None..	6.6	7.0	7.4	7.8 -
A.....	6.9	7.4	7.4 +	7.8
2.....	6.9	7.4	7.4 +	7.8
B.....	7.0	7.5	7.6	7.9
2.....	7.0	7.5	7.6 -	7.9
C.....	6.6 +	7.4 -	7.4	7.7
2.....	6.6 +	7.4 -	7.4 -	7.7
D.....	6.8 -	7.3	7.4	7.8 -
2.....	6.8 -	7.3	7.4	7.8 -
E.....	6.8 -	7.3	7.4	7.8
2.....	6.8 -	7.3	7.4	7.8
F.....	6.6	7.3	7.4	7.8 -
2.....	6.6	7.3	7.4	7.8 -
G.....	6.8 -	7.3	7.4	7.8
2.....	6.8 -	7.3	7.4	7.8
H.....	6.8 -	7.3	7.4	7.8
2.....	6.8 -	7.3	7.4	7.8
I.....	6.8 -	7.3 +	7.4	7.8
2.....	6.8 -	7.3 +	7.4	7.8
J.....	6.8 -	7.3	7.4 -	7.8
2.....	6.8 -	7.3	7.4 -	7.8
K.....	6.7	7.2 +	7.4	7.8
2.....	6.7	7.2 +	7.4	7.8
L.....	6.6 +	7.2 +	7.4 -	7.8
2.....	6.6 +	7.2 +	7.4 -	7.8

The results of these experiments present several interesting points. In the first place there was a consistent shift of reaction in the acid and neutral solutions toward the alkaline side as opposed to a lack of change in these solutions when used for the analysis of fertilizers. In this case there exists a condition just the reverse of that in the previous experiments in which the reactions of the neutral and acid solutions remain constant while that of the alkaline ones shifted towards the acid side.

The significance of this in the consideration of the analysis and composition of superphosphates is considerable. The simplest conception of superphosphate formation and reversion is that the natural tricalcium phosphate of the rock is converted into monocalcium phosphate by the action of the sulphuric acid. It then "reverts" to the dicalcium and tricalcium forms. A commercial sample of such material would then contain varying quantities of (1) the original natural phosphate, (2) monocalcium phosphate, (3) dicalcium phosphate, (4) "precipitated" tricalcium phosphate, (5) calcium sulphate and (6) sulphuric acid. In a consideration of the action of citrate solution (6) and probably (2) may be omitted, however, as both are removed in the washing to remove the water soluble phosphoric acid. It cannot be claimed therefore that the results with the commercial products were due to the sulphuric acid, and the conclusion seems inevitable that superphosphate formation and reversion is not the simple process outlined above. Such a conclusion of course invalidates any comparison between results obtained on synthetic mixtures of pure phosphates and those with commercial superphosphates so far as their serving as an index of the composition of the latter is concerned.

Passing to the analytical data on these pure phosphates, it is evident that the logical conclusions of the consideration of previous work are substantiated. The results with samples A., B. and C. show:

1. That the official procedure classes 80-90% of pure dicalcium phosphate as available.

2. That the amount dissolved decreases with the alkalinity of the solution.

3. That, roughly 17-25% of the precipitated tricalcium phosphate is rated as available.

4. That the amount of this soluble in citrate solution also decreases with the alkalinity of the citrate solution.

5. Only about 2-4% of the original rock phosphate is soluble in citrate solution.

6. Decreasing the ratio $\frac{P_2O_5}{\text{citrate}}$ and adding calcium sulphate increases the amount of phosphoric acid removed.

The results with solutions B and C as well as the two series G-I and J-L which differ only in the kind of tricalcium phosphate used verify Gladdings statement that, judged by its solubility in ammonium citrate solutions, precipitated tricalcium phosphate is much more available than the natural rock. Hence if the action of ammonium citrate is a criterion of the action of natural forces we are warranted in accepting a certain increased amount of precipitated tricalcium phosphate as available.

It is perfectly apparent from the data presented above as well as that appearing in reports by others that ammonium citrate solution is under no circumstances a differential solvent for any two forms of calcium phosphate. From results given in Table VI an approximate determination of dicalcium phosphate in the presence of rock phosphate can be obtained with an acid citrate solution, but since at least 10% of the phosphoric acid of the rock is removed the results cannot be considered as accurate beyond that figure. The question at issue is then reduced to—What conditions give results most nearly approaching those obtained in soil? This question cannot be answered except by means of vegetation experiments. It is evident that insofar as the composition and reaction of the solutions used are concerned the difference in the results obtained are relatively small, generally not exceeding 1%. This, of course, is well within the range of experimental error of vegetation experiments and it may be safely assumed that any solution selected which approximates in composition those usually considered, will give results which will agree as well as any others with figures obtained by vegetation tests. In other words, assuming the validity of the comparison between the solvent powers of approximately neutral ammonium citrate solution and the soil solution, any citrate solution having a composition within the limits of those used in the experiment reported above, may be selected as the reagent for evaluating commercial phosphates.

While any of these solutions could, from the point of view of the practical value of the phosphate, be used, it is necessary for purposes of comparing the analytical results obtained by different chemists and accurately fixing the market value of various goods that one solution be chosen and consistently used. Its selection however cannot be made on the basis of the practical value of the results obtained with it but must depend upon such considerations as the accuracy and convenience with which it can be prepared, constancy of composition, etc.

In the original description of the method and in official procedures based upon it, a neutral solution is prescribed. Owing to the un-

certainly of its composition and the difficulty of its preparation, Eastman and Hildebrand (15) suggested that a solution of the normal salt which is slightly alkaline be substituted for it. The technic described in the present paper eliminates both of these objections to the use of the neutral solution and consequently eliminates any advantage in this regard which the solution of the normal salt possesses. Using the methods described a perfectly neutral solution of ammonium citrate may be easily and accurately prepared.

In one respect the neutral solution possesses a slight advantage over the solution of normal triammonium citrate in that with most commercial fertilizers its reaction apparently remains constant throughout the determination. This, however, is but of small importance as the reaction of the alkaline solution is but little altered.

The chief recommendation for the retention of the neutral solution is perhaps simply that there is now no reason for abandoning it and since it has been prescribed for use, and supposedly has been used, for years it should still be used.

In conclusion a few words may be said regarding the proposed substitutes for ammonium citrate. These have included such solutions as dilute acids and salts other than ammonium citrate. In no case does any seem to present material advantages over the reagent at present in use. The method which seemingly is somewhat preferable is that suggested by Olsen (40) using ammonia. He claims to be able to accurately determine the three forms of calcium phosphate in commercial products. He criticises the present method for including the phosphoric acid of iron and aluminum phosphates in the available fraction, implying that his own method does not though he later states that in the presence of iron and aluminum phosphates "the problem of differentiating is somewhat complex."

CONCLUSIONS.

The indicators commonly used are unsuitable for the accurate preparation of neutral ammonium citrate solution although the results may be improved by the use of Hand's (25) technic.

Accurate results are obtainable with physical chemical methods, Hildebrand's (27) for the preparation of either neutral solutions or solutions of the normal salt, and that of Hall & Bell (23) (42) for preparing the latter, but the apparatus and technic preclude their common adoption.

Analytical methods give accurate results for making any solution whose composition is fixed.

Methods relying upon the autoneutralization of the solution by means of the heat of reaction, etc. are absolutely unreliable.

The adjustment of the reaction of the solution using phenol red as the indicator and comparing the solution colorimetrically with standard solutions whose reactions are known gives accurate results and permits the rapid and convenient adjustment and control of citrate solutions. It possesses advantages over any other method.

The composition of a neutral solution of ammonium citrate having a S. G. 1.09 at 20° has been found to be 45.33 g. NH_3 , and 172.00 g. $\text{C}_6\text{H}_8\text{O}_7$ per liter. The ratio of $\text{NH}_3:\text{C}_6\text{H}_8\text{O}_7$ is 1:3.794.

With commercial fertilizers the reaction of acid or neutral citrate solu-

tions does not change during the determination but the alkalinity of alkaline solutions is decreased. With mixtures of pure calcium phosphates and calcium sulphate the reverse is true, i. e., acid and neutral solutions become more alkaline while alkaline ones do not change.

With citrate solutions ranging in reaction from P_H 6.6 to 7.8 the magnitude of the variation in the results of the analysis of calcium phosphate is usually small. There is however a distinct decrease in the solubility of both di- and tricalcium phosphate with an increase in alkalinity.

Precipitated tricalcium phosphate is much more readily soluble in ammonium citrate solution than is raw rock phosphate.

There appears to be no good reason for changing the reagent which has been prescribed for use but the official methods for preparing this solution should be replaced by more accurate ones.

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STUDIES IN THE HEAT RESISTANT ORGANISMS OF COLD PACKED CANNED PEAS.

Technical Bulletin No. 47

INTRODUCTION.

During the past few years much has been said about food conservation, the home garden and home canning. Especially has the demonstrator attempted to help the housewife save garden vegetables which would otherwise be wasted.

These efforts have been largely successful. In many instances, however, canned vegetables have spoiled. The reason for spoilage has been given as due to the use of vegetables not fresh, or failure to follow the directions as given in the most recent Government bulletins on home canning. The question thus arose as to whether the spoilage was due to either of these causes or to both, or if this trouble might have some other origin.

It has been the writer's intention during the course of this investigation to solve this problem if possible and determine the cause for the very much larger proportion of spoilage among home canned foods as compared with those canned commercially.

REVIEW OF LITERATURE.

Probably the first bacteriological examination of spoiled canned goods was reported by Russell (26) in 1895 in connection with the occurrence of "swells" in canneries of Wisconsin. In the paper "Gaseous Fermentations in the Canning Industry" he cites the isolation from swelled canned peas of two bacilli which he did not identify. He recommended the increase of temperature to 242 degrees F. and the pressure to fifteen pounds for twenty-eight minutes.

In 1904, Harding and Nicholson (20) examined an outbreak of spoilage in canned peas. They found spoilage in which there was simply souring of the product and also spoilage in which there was gas present and malodor. A small rod or coccus caused the former and a plump rod with terminal spores which grew vigorously in the presence of sugars at 37 degrees C. caused the latter. Limits for successful processing were determined.

Duckwall (17) devoted one chapter in his book on "Canning and Preserving" (1905) to canned peas in which he discussed the history of peas, their parasites, their composition and food value, methods of canning, and bacteria associated with spoilage. The organisms discussed were those found by himself and others. He mentions lactic acid bacteria, *B. butyricus*, *B. mesentericus vulgaris*, "A butyric acid bacillus which was a strict anaerobe with terminal spores similar to *B. tetani*," *B. megatherium*, *B. prodigiosus*, *B. subtilis*, *B. mesentericus ruber*, *B. mycoides* and some organisms not named but described. He

recommended a longer processing period at a higher temperature, for canned goods.

Hite, Giddings and Weakley (21) determined the effect of pressure alone on *B. subtilis*. Vegetative forms of *B. subtilis* suspended in distilled water were subjected to pressures of from 20,000 to 100,000 pounds for periods of time varying from a few seconds to 120 minutes. Out of fifty-seven tests *B. subtilis* was killed in only seven.

A pressure of 30,000 pounds was applied at a temperature of 48 to 50 degrees C. for a few minutes to several hours, to more than two hundred cans of fruits and vegetables. All the vegetables, which included corn, peas, beans, beets, radishes and potatoes, promptly spoiled, while not one of more than a hundred cans of peaches which were compressed spoiled. Experiments with other fruits were not so successful. This pressure (30,000 pounds) was found to give uniformly good results with fruit juices.

Zavalla (32) published a book in 1916 on "Canning of Fruits and Vegetables." In Part III, he discusses spoilage, giving a report on two hundred and eighty-five bacteriological examinations of canned foods from six canneries. Nine spore formers were described but not named. Gas was found in cans of peas but these organisms did not form gas in sugar fermentation tubes.

Dickson (16) in 1917 investigated an occurrence of botulism on the Pacific Coast, finding *B. botulinus* in three cases. He then inoculated canned peas, beans, and corn with *B. botulinus*, heating them at a boiling temperature presumably in accordance with Government bulletin directions. These developed gas in three weeks. *B. botulinus* and *B. subtilis* were recovered from the cans. He concluded that the time given in the directions for processing in the Government bulletins is insufficient.

The Department of Agriculture (30) answered this paper by saying that the spores of *B. botulinus* are killed by one hour of heating at 175 degrees F. and that there is, therefore, no danger from *B. botulinus* in canned foods. It was also stated that the toxin from *B. botulinus* is destroyed by boiling a few minutes. However, a warning was given against eating foods showing any signs of spoilage.

In the bulletin entitled, "Bacteriological Examination of Canned Foods" (1917), A. W. and K. G. Bitting (4) discuss leaks, springers, the proper method for opening tin cans for examination, pressure in cans, swells and flat sours, and organisms of spoilage. They determined by experiment that it takes a tin can of peas when undisturbed, over twenty minutes to reach 248 degrees F. Cans are more uniformly heated when agitated. Organisms found were a large lactic acid bacillus, a coccus form which produced malodor, and thermophilic forms in appearance similar to *B. tetani* and *B. botulinus*. They state that a much higher temperature is required to destroy the spores of some organisms than of others.

Georgia Spooner Burke (8) states in her article on "The Effect of Heat on the Spores of *B. Botulinus*" (1918) that *B. botulinus* toxin is destroyed by five minutes of boiling, but the spores are not killed in jars of fruit by boiling for five hours. They will also survive three and one half hours of boiling in an open kettle or fifteen pounds of pressure in the autoclave for ten minutes. She concluded that pressure cooking is the only sure method of avoiding spoilage by *B. botulinus*.

In 1918 Bushnell (9) experimented on the influence of cold shock on the sterilization of foods, working with both glass jars and test tubes. He found that cold shock did not promote the keeping qualities of canned food. Exclusion of air, however, prevented aerobic organisms from developing when their spores were present.

Minna Denton (14) investigated various factors which influence the length of time required for heat penetration in mason jars. Ordinary mercury thermometers inserted through the can cover were used in these experiments, in which carrots only were employed. It was determined that increasing the vegetable mass by about two and consequently decreasing the amount of water added to the jar, almost doubled the time required for heat penetration to the center of the jar. Miss Denton makes a point of the fact that in the more solid pack there was an interval of 115 minutes when the temperature remained above 80 degrees C; later, however, she suggests that various strains of *B. botulinus* may have higher thermal death points than Van Ermenegem's strain whose spores were destroyed at this temperature. Another point brought out is that two women using the same material and following each step with equal care and intelligence may often obtain very different results since the time for the interior of the can to reach a temperature near the boiling point may vary from 30 to 100 minutes and easily could vary more widely. The statement is made that "with any given period of processing, the longer the time required to heat through to the center of the mass, the shorter the time remaining for the accomplishment of sterilization."

Cheyney (11) examined bacteriologically "seven hundred and twenty-five cans of merchantable foods in prime condition" and found fifty-eight or eight per cent to contain living micro-organisms. Fruits showed living microbes in a uniform average of three per cent of the cans examined, with vegetables the percentage was eight, and with meat and fish it varied from ten to twenty per cent of all cans. The organisms isolated from peas were *B. vulgatus* (Flügge), *B. mesentericus* (Flügge-Migula), and *B. subtilis* (Cohn). *B. vulgatus* is perhaps the most frequent type found in canned foods containing viable organisms because such cans are very frequently "leaks." Of the forty-nine cans of fruits, vegetables, etc., found leaky, thirty-seven per cent contained living organisms. Six cans of peas which were found to be sterile may have been leaks. *B. mesentericus* "is typical of apparently perfect cans which retain bacteria in spite of standard processing." The cans (No. 2) of peas containing these organisms were processed from 30 minutes at 235 degrees F. to 45 minutes at 240 degrees F. in different factories.

J. Weinzirol (31) in his thesis entitled, "The Bacteriology of Canned Foods" gives his results from investigation of one thousand and eighteen samples of canned goods. Besides molds and yeasts, he isolated three hundred and ninety-two bacteria, representing thirty-eight species. The most prevalent organisms found were *B. mesentericus*, *B. subtilis*, *B. thermoidifferens*, *B. vulgatus* and *B. cercus*.

He concludes that spores may be present in apparently unspoiled canned goods as found on the market. These may be unable to grow due to lack of oxygen. Vacuum is essential for the preservation of foods under the present methods of processing. Food poisoning organisms, *B. botulinus* and *B. enteritidis* are not found in commercially canned foods.

Eva M. Brnett (7) used the well-known equation of monomolecular reactions in investigating the shock effect of the blanching followed by cold dipping upon the spores of *B. pseudo-tetanicus*. This is expressed:

$$k = \frac{1}{t} \log \frac{B}{b}$$

in which k = velocity coefficient of the rate of death of bacteria, a constant,

t = interval of time between observations,

B = number of bacteria at beginning of any time interval,

b = number of bacteria at end of time t .

She concludes from the data obtained that "The bacteriological utility of the blanching in the cold pack process of canning probably should not be ascribed to shock" as bacterial spores are apparently not made more sensitive to heat by preliminary heating followed by chilling; rather, what little justification blanching has from the bacteriological standpoint should be ascribed to its initial cleansing action, and as the time required for sterilization probably varies directly in proportion to the initial contamination it is desirable to reduce this as much as possible. The suggestion is made that the blanching process may so influence the hydrogen ion concentration of the liquid that the time needed for sterilization would be markedly influenced.

Carrie E. Castle (10) in experimenting with intermittent heating (1 hr. on 3 successive days) says that in the hot water bath method, the jars should not only be completely immersed in the water but the water should be cold when they are introduced and only brought to the boiling point afterwards. Loosely packed jars only should be used in canning by usual home methods. With shallow water baths the maximum interior temperatures were considerably lower than in the deeper baths and the higher temperatures in the latter cases were maintained for longer periods.

Bovie and Bronfenbrenner (6) describe an apparatus employing thermo-couples for measuring the rate of heat penetration in tin cans of navy beans. The graph given at the close of their article shows that although a constant autoclave temperature of 280 degrees F. was reached in 15 minutes, the interior of the can did not approximate this temperature for much more than 15 minutes during the last of the 180 minute processing period.

Thompson (27) by using thermo-couples embedded in the center of cans of various foods, asparagus, carrots, chard, cherries, corn, peas, strawberries, spinach, string beans, and squash, determined the temperature-time curves when the cans were subjected to various temperatures in hot water, steam, cool air and cool water. From his experiences a chart of time-temperature relations has been constructed which may be used for determining approximately the temperature at the center of a can at any time after immersion in the processing bath which is maintained at a constant temperature. A chart of this kind devised for variable bath temperatures would be of the greatest use in solving the bacteriological problems of food canning.

The article by Larson, Cantwell and Hartzell (23) suggests to the author of this bulletin that one explanation of the growth or lack of growth of the spores of aerobes or anaerobes in canned foods may be that the vegetable, fruit, etc., itself, or its extractives or various additions such as salt, sugar, etc., change the surface tension as well as other physical characteristics of the medium thus changing the growth characteristics of the organisms present.

Then too, it was suggested to the writer that the presence of the vacuum in a can may so serve to lower the surface tension as to influence markedly the growth of living organisms therein.

Tonney and Gooken (28) using the Morehead gas burette made analyses of the gases from a number of cans of spoiled vegetables, fruit, and fish ("swells"). Their results for spoiled canned peas are given in the following table:

PER CENT

CO ₂	O ₂	H ₂	N ₂	Acidity as acetic acid.
66.30	.....	.....	33.70	0.73
74.90	0.5	.....	24.60	0.41
72.60	.....	.....	27.40	0.40
78.15	0.6	.....	21.25	0.66
98.20	.....	.....	.....	0.52
75.97	.....	.....	24.03	0.44
73.30	0.5	9.67	16.53	0.26
43.20	4.5	7.85	48.47	0.36

The nitrogen which will be noted was obtained by difference and is very high, is considered by the authors to be "a rough index of the amount of proteid decomposition which has taken place, and as such has important bearing on the likelihood of the presence of ptomaines. In general it may be said that nitrogen indicates putrefaction and carbon dioxide indicates fermentation. * * * The presence of hydrogen, * * * is believed by the writers to be an especially valuable indication of ptomaine producing processes."

In the work on spoiled meats by K. George Falk, Emil J. Baumann and Grace McGuire (18) it was determined that all organisms experimented with produced an increase in ammonia. *B. proteus* and *B. paratyphosus* produced a marked increase of creatinin. Other organisms produced definite changes in the protein present. The test for ammonia they concluded could be used for determination of meat spoilage.

METHOD OF PROCEDURE.

In the summer of 1918 between the first and twentieth of July in connection with an experiment in soils, thirteen lots of peas were picked, weighed, and later canned in accordance with the Government methods for cold pack canning. One lot was heated in steam; five were cooked by the hot water bath method; and seven lots were processed in the autoclave at fifteen pounds pressure. Lot A H X is the only one where the canning was done the same day that the peas were picked. In lot HWB I and A VI the peas were kept at room temperature over night.

All others were kept in the refrigerator. All of these peas except lot A II X mentioned above, were partly shelled one day, then kept until the next day when the shelling was finished and they were canned.

Within two weeks, spoilage began to occur. The following table gives the data showing the percentage of spoilage in each lot:

TABLE I

Lot.	Jar.	Size.	Time.	No. of cans.	Spoilage.
*A I.....	Mason.....	Pts.....	40 min.....	7	7
A II O.....	Mason.....	Pts.....	40 min.....	17	1
A II X.....	Mason.....	Pts.....	40 min.....	33	4
A III.....	Seal-fast.....	Pts.....	40 min.....	30	20
A IV.....	Mason.....	Qts., 1 Pt.....	1 hr.....	21	19
A V.....	Mason.....	Qts., 1 Pt.....	1 hr.....	14	14
A VI.....	Mason.....	Qts., 1 Pt.....	1 hr.....	4	1
*HWP I.....	Mason.....	Pts., Qts.....	3 hrs.....	4	1
HWB II.....	Mason.....	Pts., Qts.....	3 hrs.....	3	3
HWB III.....	Seal-fast.....	Pts.....	3 hrs.....	21	18
HWB IV.....	Mason.....	Pts.....	3 hrs.....	27	19
HWB V.....	Seal fast.....	Pts.....	3 hrs.....	17	5
*S I.....	Mason.....	Pts., Qts.....	3 hrs.....	15	11

Per cent spoilage of those autoclaved, 50.9 per cent.

Per cent spoilage in peas (lot A II X only) autoclaved the same day as shelled, 12.1 per cent.

Per cent spoilage of peas autoclaved 40 min, the next day after shelling (3 lots), 51.9 per cent.

Per cent spoilage of peas autoclaved 1 hr. the next day after shelling (3 lots), 87. 2 per cent.

The high percent of spoilage in the lot autoclaved for 1 hr, in all probability is due to the size of cans used.

Per cent spoilage of those cooked in hot water bath, 63.9 per cent.

Per cent spoilage of those cooked in steam, 73.3 per cent.

*Lots A I, II, etc., were processed in the autoclave at 15 lbs. pressure. Lots HWB I, II, etc., were processed in the hot water bath. Lot S was processed in flowing steam.

Five cans were selected for examination from lot A I and five from A V in each lot of which the spoilage was complete.

Each of these cans was examined before opening for evidences of a "swell," i. e., for gas, leakage and any other evidences of spoilage; the can was then carefully washed with a 1-1000 mercuric chloride solution, alcohol was poured over the cover and then burned off, and the can cover lifted only sufficiently to obtain samples of the juice with a pipette.

Five cubic centimeters of the juice was titrated to determine the acidity. Duplicate sets of dilution plates of 1 to 100, 1 to 10,000 and 1 to 100,000 were made. One set of these was placed under anaerobic conditions, using a Novy jar filled with hydrogen. One hundredth of a cubic centimeter was smeared uniformly over one square centimeter on a slide and stained to obtain a direct microscopic count and to determine as well the types of vegetative forms present. Two sets of gelatin agar* shakes were made by the loop dilution method. One set was heated to 80 degrees C. while still liquid for the determination of the presence of spores.

All cultures were incubated at room temperature. A gelatin agar shake culture was made of each anaerobe isolated. When the anaerobe proved to be in pure culture, transfers were made into two tubes of sterile peas in distilled water.** About one centimeter of sterile white paraffin oil was poured into one tube of each set in order to give an-

*Gelatin agar medium: Bouillon cubes, 3 gms.; peptone, 10 gms.; salt, 5 gms.; dextrose, 20 gms.; gelatin, 20 gms.; agar, 14 gms.; water, 1000 c.c. Adjusted to -1.5 per cent normal to phenolphthalein, or left unadjusted (about neutral) according to needs of organisms.

**Peas used as a nutrient medium were prepared by filling test tubes about one-third full with peas taken from a can of apparently sterile peas, covering the peas with distilled water and sterilizing in the autoclave.

aerobic conditions (23). After the action in this medium was determined under both aerobic and anaerobic conditions, cultures were made in all media used commonly for identification purposes. Cultures were also made in a one per cent starch-peptone solution to determine the reduction of starch to sugar and the production of acid. The thermal death point and measurements were made of each organism. By comparison of results, it was determined which organisms occurred in more than one can.

Commercially canned peas were also inoculated with *Bacillus A* after sterility was determined. These were resealed with solder and incubated at room temperature for three months. "Swells" were produced in all cases.

These cans were then washed with 1-1000 mercuric chloride solution, the gas drawn off, resealed with paraffin and placed in the ice box so that further changes would be held in check as much as possible.

The gas was measured and the percentage composition determined by means of absorption pipettes and the explosion pipette.

The contents of the can, the juice and the peas respectively, were then analyzed for total nitrogen and for ammonia, and the peas only for creatinin and creatin. The titre and pH of the juice was also determined. These determinations were made by approximately the same methods as those used with spoiled meats by Falk, Baumann and McGuire (18).

Known organisms having similar characteristics were then inoculated into aerobic and anaerobic tubes of peas to determine their action in this medium.

TABLE II

LOT A I, HEATED FORTY MINUTES IN THE AUTOCLAVE AT 15 POUNDS PRESSURE.

Can No.	A I 1	A I 2	A I 3	A I 4	A I 5
Jar.....	Pint Mason.....	Pint Mason	Pint Mason.....	Pint Mason.....	Pint Mason.
Cloudy.....	+ Sediment....	+ Sediment....	+	+	+
Gas.....	+	—	+	+	+
Swell.....	—	—	—	—	—
Leak.....	—	Reautoclaved.	—	—	—
Acidity.....	.028/N	.033/N	.033/N	.025/N	.045/N
Odor.....	Normal.....	Nearly normal..	Normal.....	Normal.....	Nearly normal
Bacterial count per c. c.:					
Aerobic.....	2,750	7,150	3,435,000	622,000	295,000
Anaerobic.....	Spreader	Liquefier	24,407,000	Spreader	350,000
Direct microscopic count.....	14,221,000	569,084,000	43,923,000	1,611,000	47,000
Organisms isolated.....	3	14	3	3	2

†Pea starch and peptone, each in 1 per cent amounts comprise this medium.

TABLE III

LOT A V, HEATED ONE HOUR IN THE AUTOCLAVE AT 15 POUNDS PRESSURE.

Can No.	A V 10	A V 11	A V 12	A V 13	A V 14
Jar.....	Qt. Mason	Qt. Mason	Qt. Mason	Qt. Mason	Pt. Mason
Cloudy.....	+	+	+Sediment	+	+
Gas.....	+	+	+	+	+
Swell.....	-	+	+	+	-
Leak.....	+	Resealed not heated	Resealed not heated	+	+
Acidity.....	.076/N	.086/N	.082/N	.102/N	.073/N
Odor.....	Nearly normal..	Nearly normal..	Normal.....	Butyric.....	Normal.
Bacterial count per c. c.:					
Aerobic.....	361,000	700	300,000	776,000	48,000
Anaerobic.....	360,000	200	Spreader	796,000	8,679,000
Direct microscopic count.....	3,033,856,000	568,848,000	568,858,000	209,612,000	2,439,772,000
Organisms isolated.....	2	2	3	4	1

ORGANISMS ISOLATED.

Bacillus A.

Found in cans A I 1, A I 3, A I 5, A V 10, A V 13, A V 14.

I. Morphology:

1. Vegetative Cells:

- (a) Form—Small rod.
- (b) Limits of size—1.5-2 x 0.5 microns.

2. Endospores:

- (a) Position—Central.
- (b) Form—Oval.
- (c) Produce slight enlargement of the rod.
- (d) Spores not produced in broth.

3. Motility:

- (a) Actively motile.

4. Staining:

- (a) Gram negative.
- (b) Stains with ordinary dyes.

II. Cultural Characteristics:

1. Gelatin Stab:

- (a) Growth—Best at top.
- (b) Liquefaction—Napiform becoming stratiform.

2. Nutrient Broth:

- (a) Surface growth—Pellicle, settles on shaking.
- (b) Cloudy.

3. Litmus Milk:
 - (a) Peptonization—Slow.
 - (b) Reduction from the bottom upward becoming a tan colored liquid.
 - (c) Alkaline.
4. Glycerin Potato:
 - (a) Abundant, flat.
 - (b) Dull, finely wrinkled.
 - (c) Cream colored, becoming tan.
 - (d) Water in bottom pinkish.
5. Gelatin Agar Colony:
 - (a) Growth—Rapid.
 - (b) Flat.
 - (c) Form—Spreading.
 - (d) Semitransparent.

III. Physical and Biochemical Features:

1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
Gas—Negative.
Reaction—Acid.
 - (b) Lactose:
Gas—Negative.
Reaction—Alkaline.
 - (c) Saccharose:
Gas—Negative.
Reaction—Acid.
2. Peas in distilled water: *
 - (a) Aerobic tubes:
Gas.
Creamy top growth becoming deep red underneath;
chromogenesis more readily produced at 37 degrees
C.
 - (b) Anaerobic tubes:
Gas.
Not much visible growth, no color.
3. Peptone Solution:
 - (a) Indol production, slight.
4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia production.
5. Starch Peptone Solution, neutral:
 - (a) Starch reduction.
 - (b) Slight test for sugar.
 - (c) Slight acid.

*See foot note on page 10.

6. Temperature Relations:

- (a) Growth at room temperature.
- (b) Favored by 37 degrees C.
- (c) Not killed by heating at 120 degrees C. for ten minutes.
- (d) Killed by heating at 120 degrees C. for twenty minutes.

Bacillus B.

(Conforms to description of *B. subtilis* as given by Ford.)

Found in cans A I 1, A I 2, A I 3, A I 4, A I 5, A V 11, A V 12, A V 13.

I. Morphology:

1. Vegetative Cells:

- (a) Rod.
- (b) Size—2.5-4.5 x 0.5-0.75 microns.

2. Endospores:

- (a) Position—Central or nearly so.

3. Motility:

- (a) Actively motile.

4. Staining:

- (a) Gram positive.
- (b) Stains with ordinary dyes.

II. Cultural Characteristics:

1. Gelatin Stab:

- (a) Top growth.
- (b) Liquefaction—Nearly crateriform.

2. Nutrient Broth:

- (a) Heavy top growth not easily broken.
- (b) Broth nearly clear, yellowed.

3. Litmus milk:

- (a) Peptonization.
- (b) Alkaline.

4. Glycerin Potato:

- (a) Very abundant growth.
- (b) Dull, rugose.
- (c) Cream colored.

5. Gelatin Agar Colonies:

- (a) Growth—Rapid.
- (b) Granular.
- (c) Rhizoid.
- (d) White.

III. Physical and Biochemical Features:

1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
Gas—None.
Reaction—Acid.
Heavy top growth.
 - (b) Lactose:
Gas—None.
Reaction—Alkaline.
Heavy top growth.
 - (c) Saccharose:
Gas—None.
Reaction—Acid.
Top growth.
2. Peas in distilled water:
 - (a) Aerobic culture:
Gas production.
Cream colored, wrinkled growth, darkens.
Slime production.
 - (b) Anaerobic culture:
Gas production.
Slime.
Yellowish liquid.
3. Peptone Solution:
 - (a) Indol formation.
4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia production.
5. Starch Peptone Solution:
 - (a) Complete reduction of starch.
 - (b) Large quantity of sugar.
 - (c) Solution, slightly alkaline.
6. Temperature Relations:
 - (a) Grows readily at room temperature.
 - (b) Favored by 37 degrees C.
 - (c) Not killed by heating at 120 degrees C. for ten minutes.
 - (d) Killed by heating at 120 degrees C. for twenty minutes.

Bacillus C.

(Resembles *B. botulinus* morphologically and culturally.)

Found in can A I 2.

I. Morphology:

1. Vegetative Cells:
 - (a) Large rod with rounded ends.
 - (b) Size—4.6 x 0.75 microns.

2. Endospores:
 - (a) Position—Polar or sub-terminal making the rod club-shaped.
3. Motility:
 - (a) Actively motile.
4. Staining:
 - (a) Gram positive.
 - (b) Stains with ordinary dyes.

II. Cultural Characteristics:

1. Nutrient Broth under oil:
 - (a) Broth cloudy.
 - (b) Odor of butyric acid.
2. Gelatin Agar Colonies:
 - (a) Anaerobic.
 - (b) Furry.
 - (c) Whitish, becomes somewhat tan.
3. Dextrose Gelatin Agar Shake:
 - (a) Gas at 25 degrees C.
 - (b) No gas at 37 degrees C.

III. Physical Characteristics:

1. Temperature Relations:
 - (a) Growth best at 25 degrees C.
 - (b) Slow growth at 37 degrees C.
 - (c) Not killed by heating at 120 degrees C. for ten minutes.
 - (d) Killed by heating at 120 degrees C. for twenty minutes.

Bacillus D.

Found in can A I 2.

I. Morphology:

1. Vegetative Cells:
 - (a) Slender rods.
 - (b) Size—1.5-3 x .5 microns.
2. Endospores:
 - (a) Position—Central.
 - (b) Slight enlargement of the rod on sporulation.
 - (c) Spores—Oval.
3. Motility:
 - (a) Actively motile.
4. Stain:
 - (a) Gram negative.
 - (b) Stains with ordinary dyes.

II. Cultural Characteristics:

1. Gelatin Stab:
 - (a) Liquefaction—Infundibuliform.
2. Nutrient Broth:
 - (a) No top growth.
 - (b) Cloudy.
 - (c) Sediment.
3. Litmus milk.
 - (a) Peptonization.
 - (b) Alkaline.
4. Glycerin Potato:
 - (a) Flat, smooth, glistening growth.
 - (b) Color, creamy tan.
5. Gelatin Agar Colonies:
 - (a) Flat.
 - (b) Spreading.
 - (c) White, turning tan in forty-eight hours.

III. Physical and Biochemical Features:

1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
Gas—None.
Reaction—Slightly acid.
 - (b) Lactose:
Gas—None.
Reaction—Alkaline.
 - (c) Saccharose:
Gas—None.
Reaction—Acid.
2. Peas in distilled water:
 - (a) Aerobic culture:
Gas.
Creamy top growth.
 - (b) Anaerobic culture:
Gas.
3. Peptone Solution:
 - (a) No indol production.
4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia production.
5. Starch Peptone Solution:
 - (a) None or very slight reduction of starch.
 - (b) No production of sugar.
 - (c) Slight acid.

6. Temperature Relations:

- (a) Growth both at 25 degrees and 37 degrees C.
- (b) Not killed by heating at 120 degrees C. for ten minutes.
- (c) Killed by heating at 120 degrees C. for twenty minutes.
- (d) Withstands $3\frac{1}{2}$ hours heating in flowing steam.

Bacillus E.

(Resembles *B. ramosus*.)

Found in cans A V 10, and A V 12.

I. Morphology:

- 1. Vegetative Cells:
 - (a) Thick rods.
 - (b) Size— $2.3.5 \times 0.75-1$ microns.
- 2. Endospores:
 - (a) Position—Central.
- 3. Motility:
 - (a) Motile, not active.
- 4. Staining:
 - (a) Gram positive.
 - (b) Stains with ordinary dyes.

II. Cultural Characteristics:

- 1. Gelatin Stab:
 - (a) Liquefaction—Crateriform to stratiform.
 - (b) Whitish sediment which turns pinkish.
- 2. Nutrient Broth:
 - (a) Top growth flaky which settles on shaking.
- 3. Litmus milk:
 - (a) Peptonization.
 - (b) Alkaline.
- 4. Glycerin Potato:
 - (a) Growth—Abundant, raised, contoured.
 - (b) Moist, creamy to pink, becoming purplish.
- 5. Gelatin Agar Colony:
 - (a) Flat.
 - (b) Sometimes somewhat spreading.
 - (c) White, translucent.

III. Physical and Biochemical Features:

- 1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
 - Gas—None.
 - Reaction—Acid.

- (b) Lactose:
 - Gas—None.
 - Reaction—Slightly alkaline.
- (c) Saccharose:
 - Gas—None.
 - Reaction—Acid.
- 2. Peas in distilled water:
 - (a) Aerobic culture:
 - Gas.
 - Somewhat rose colored top growth.
 - (b) Anaerobic culture:
 - Gas.
- 3. Peptone Solution:
 - (a) Indol formation.
- 4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia formation.
- 5. Starch Peptone Solution:
 - (a) Slight reduction of starch.
 - (b) Slight test for sugar.
- 6. Temperature Relations:
 - (a) Grows readily at either 25 degrees or 37 degrees C.
 - (b) Not killed by heating at 110 degrees C. for ten minutes.
 - (c) Killed by heating at 110 degrees C. for thirty minutes.

Bacillus H.

Found in cans A I 3, and A I 4.

I. Morphology:

- 1. Vegetative Cells:
 - (a) Rods usually in long chains.
 - (b) Size—2.5-3 x 0.5 microns.
- 2. Motility:
 - (a) Slowly motile.
- 3. Endospores:
 - (a) Central.
- 4. Staining:
 - (a) Gram positive.
 - (b) Stains with ordinary dyes.

II. Cultural Characteristics:

- 1. Gelatin Stab:
 - (a) Liquefaction—Crateriform.

2. Nutrient Broth:
 - (a) No top growth.
 - (b) Medium cloudy.
 - (c) Fine precipitate.
3. Litmus milk:
 - (a) Peptonization.
 - (b) Reduction.
 - (c) Alkaline.
4. Glycerin Potato:
 - (a) Growth—Moderate.
 - (b) Dull creamy yellow growth.
5. Gelatin Agar Colony:
 - (a) Granular.
 - (b) White.
 - (c) Lacerate edges.

III. Physical and Biochemical Features:

1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
 - Gas—None.
 - Reaction—Acid.
 - Green iridescence.
 - (b) Lactose:
 - Gas—None.
 - Reaction—Alkaline.
 - (c) Saccharose:
 - Gas—None.
 - Reaction—Acid.
2. Peas in distilled water:
 - (a) Aerobic cultures:
 - Gas.
 - Very moist growth which develops a touch of bright tan color.
 - (b) Anaerobic culture:
 - Gas.
3. Peptone Solution:
 - (a) Indol production.
4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia production.
5. Starch Peptone Solution:
 - (a) Starch reduction.
 - (b) No test for sugar.
6. Temperature Relations:
 - (a) Grows readily both at 25 degrees and 37 degrees C.
 - (b) Not killed by heating at 120 degrees C. for ten minutes.
 - (c) Killed by heating at 120 degrees C. for twenty minutes.

Bacillus K.

Found in can A I 4.

I. Morphology:

1. Vegetative Cell:
 - (a) Large rod, usually in short chains.
 - (b) Size— $2-4.25 \times 0.75$ microns.
2. Endospores:
 - (a) Position—Central.
3. Motility:
 - (a) Slowly motile.
4. Staining:
 - (a) Gram negative.
 - (b) Stains with ordinary dyes.

II. Cultural Characteristics:

1. Gelatin Stab:
 - (a) Liquefaction—Crateriform.
2. Nutrient Broth:
 - (a) Top growth finely wrinkled.
 - (b) Medium clear.
3. Litmus milk:
 - (a) Peptonization.
 - (b) Reduction.
 - (c) Alkaline.
4. Glycerin Potato:
 - (a) Growth—Moderate, contoured, raised.
 - (b) Dry, chalky white growth.
5. Gelatin Agar Colony:
 - (a) Regular.
 - (b) White with thicker creamy spot in center.

III. Physical and Biochemical Features:

1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
Gas—None.
Reaction—Acid.
Iridescent.
 - (b) Lactose:
Gas—None.
Reaction—Alkaline.
 - (c) Saccharose:
Gas—None.
Reaction—Acid.

2. Peas in distilled water:
 - (a) Aerobic culture:
Gas.
Heavy, creamy, wrinkled top growth.
 - (b) Anaerobic culture:
Gas.
3. Peptone Solution:
 - (a) Indol formation.
4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia production.
5. Starch Peptone Solution:
 - (a) Starch reduction.
 - (b) No test for sugar.
 - (c) Reaction—Alkaline.
6. Temperature Relations:
 - (a) Growth at 25 degrees C.
 - (b) Favored by 37 degrees C.
 - (c) Not killed by heating at 110 degrees C. for forty minutes.
 - (d) Killed by heating at 120 degrees C. for ten minutes.

Bacillus Y.

Found in can A V 12.

I. Morphology:

1. Vegetative Cells:
 - (a) Very large rod.
 - (b) Size—3.5 x 1 micron.
2. Endospores:
 - (a) Position—Subterminal.
 - (b) Formed within forty-eight hours.
 - (c) Shape—Slightly oval.
3. Motility:
 - (a) Slowly motile.
4. Staining:
 - (a) Gram negative.
 - (b) Stains with ordinary dyes.

II. Cultural Characteristics:

1. Gelatin Stab:
 - (a) Top growth, light orange.
 - (b) Liquefaction—Napiform becoming stratiform.
2. Nutrient Broth:
 - (a) Top growth, ring.
 - (b) Medium very cloudy.

3. Litmus milk:
 - (a) Reduction in twenty-four hours.
 - (b) Coagulation in thirty-six hours.
 - (c) Reaction—Acid.
4. Glycerin Potato:
 - (a) Growth vigorous.
 - (b) Dull wrinkled whitish growth.
5. Gelatin Agar Colony:
 - (a) Tree-like spreading growth.
 - (b) White in color.

III. Physical and Biochemical Features:

1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
Gas—None.
Reaction—Acid.
 - (b) Lactose:
Gas—None.
Reaction—Neutral.
 - (c) Saccharose:
Gas—None.
Reaction—Neutral.
2. Peas in distilled water:
 - (a) Aerobic culture:
Gas.
Moist growth with touch of bright tan color.
 - (b) Anaerobic culture:
Gas—None.
White growth beneath surface of oil.
3. Peptone Solution:
 - (a) Indol formation.
4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia formation.
5. Starch Peptone Solution:
 - (a) Starch reduction.
 - (b) No sugar.
 - (c) Reaction—Acid.
6. Temperature Relations:
 - (a) Growth at both 25 degrees C. and 37 degrees C.
 - (b) Not killed by heating at 120 degrees C. for ten minutes.
 - (c) Killed by heating at 120 degrees C. for twenty minutes.

Bacillus Z.

Found in can A V 13.

I. Morphology:

1. Vegetative Cell:
 - (a) Slender rod.
 - (b) Size—1.2 x 0.5 microns.
2. Endospores:
 - (a) Produced subterminally.
 - (b) Shape—Oval.
3. Motility:
 - (a) Actively motile.
4. Staining:
 - (a) Gram negative.
 - (b) Stains with ordinary dyes.

II. Cultural Characteristics:

1. Gelatin Stab:
 - (a) Liquefaction—Infundibuliform.
2. Nutrient Broth:
 - (a) Top growth soft and heavy; breaks producing a cloudy precipitate.
3. Litmus milk:
 - (a) Increased alkalinity.
 - (b) No peptonization, curd or reduction.
4. Glycerin Potato:
 - (a) Potato gray.
 - (b) Growth flat, yellowish gray.
5. Gelatin Agar Colony:
 - (a) Raised.
 - (b) Glistening.
 - (c) Yellowish white.

III. Physical and Biochemical Features:

1. Fermentation tubes, neutral red broth plus
 - (a) Dextrose:
 - Gas—None.
 - Reaction—Neutral.
 - (b) Lactose:
 - Gas—None.
 - Reaction—Neutral.
 - (c) Saccharose:
 - Gas—None.
 - Reaction—Neutral.

2. Peas in distilled water:
 - (a) Aerobic Culture:
Gas—None.
Heavy creamy wrinkled top growth, liquid yellowed.
 - (b) Anaerobic Culture:
Gas—None.
Growth beneath surface of oil.
3. Peptone Solution:
 - (a) Indol formation.
4. Nitrate Peptone Solution:
 - (a) Nitrate reduction.
 - (b) Ammonia production.
5. Starch Peptone Solution:
 - (a) Starch reduction.
 - (b) Test for sugar.
6. Temperature Relations:
 - (a) Grow at 25 degrees C.
 - (b) Favored by 37 degrees C.
 - (c) Not killed by heating at 110 degrees C. for twenty minutes.
 - (d) Killed by heating at 110 degrees C. for thirty minutes.

CULTURAL CHARACTERISTICS IN PEAS* OF COMMON SPORE-BEARING BACTERIA.

As *B. subtilis* and other common spore-forming bacteria correspond quite closely in all ordinary cultural and morphological characteristics with certain of the bacteria just described, this suggested that perhaps certain aerobic bacteria of this type possess the other definite and typical cultural characteristics which would correlate them with certain of the unidentified bacteria. Consequently *B. subtilis*, *B. ramosus*, *B. mycoides* and *B. mesentericus vulgatus*, the four species which correspond most closely with the organisms isolated, along with other common bacteria, were grown in sterile peas both aerobically and under oil with the following results:

I. *B. subtilis*.

1. Aerobic Culture:
 - (a) Gas after forty-eight hours.
 - (b) Abundant top growth.
 - (c) Growth dull, wrinkled, cream colored.
 - (d) Favored by 37 degrees C.
 - (e) Liquid yellowed.
2. Anaerobic Culture:
 - (a) Gas formation—None.
 - (b) Growth—Below surface of oil.

*See foot note on page 10.

II. *B. ramosus*.

1. Aerobic Culture:

- (a) Gas production in twenty-four hours.
- (b) Abundant top growth.
- (c) Growth—Moist, white, turning pink, then deep red below surface of top growth.

2. Anaerobic Culture:

- (a) Gas production in twenty-four hours.
- (b) Growth—Below surface of oil, but no color.

III. *B. mycoides*.

1. Aerobic Culture:

- (a) Gas—None.
- (b) Top growth slow in developing.
- (c) Growth—Moist, white.
- (d) Hindered by 37 degrees C.

2. Anaerobic Culture:

- (a) Gas—None.
- (b) Growth—Below surface of oil.

IV. *B. mesentericus vulgaris*.

1. Aerobic Culture:

- (a) Gas—None.
- (b) Top growth slight.
- (c) Growth—Light tan in color.
- (d) Growth hindered by 37 degrees C.

2. Anaerobic Culture:

- (a) Gas—None.
- (b) White growth in tube.

V. *B. megaterium*.

1. Aerobic Culture:

- (a) Gas—None.
- (b) White top growth.

2. Anaerobic Culture:

- (a) Gas—None.
- (b) Growth below surface of oil.

VI. *Ps. campestris*.

1. Aerobic Culture:

- (a) Gas—None.
- (b) White growth.

2. Anaerobic Culture:

- (a) Gas—None.
- (b) Growth below surface of oil.

VII. *B. prodigiosus*.

1. Aerobic Culture:
 - (a) Gas production in forty-eight hours at 25 degrees C. and 37 degrees C.
 - (b) Red color produced throughout tube, reddest at top.
2. Anaerobic Culture:
 - (a) Gas production in 96 hours at 37 degrees C. No gas at 25 degrees C.
 - (b) Growth throughout tube but no color.

VIII. *B. ruber*.

1. Aerobic Culture:
 - (a) Gas production in twenty-four hours at 37 degrees C.
 - (b) Gas in forty-eight hours at 25 degrees C.
 - (c) Red color prominent at 37 degrees C. Slight at 25 degrees C.
2. Anaerobic Culture:
 - (a) Gas production in twenty-four hours at 37 degrees C.
 - (b) No gas at 25 degrees C.
 - (c) Slight red color beneath the oil.

IX. *B. aerogenes*.

1. Aerobic Culture:
 - (a) Gas production in twenty-four hours at both 25 degrees C. and 37 degrees C. in large volume.
 - (b) Whitish growth throughout the tube.
2. Anaerobic Culture:
 - (a) Gas production in twenty-four hours at both 25 degrees C. and 37 degrees C. in large quantities.
 - (b) Whitish growth throughout the tube.

X. *B. viscosus*.

1. Aerobic Culture:
 - (a) Large volume of gas in twenty-four hours at both 25 degrees C. and 37 degrees C.
 - (b) Decided cloudiness of liquid.
2. Anaerobic Culture:
 - (a) Large volume of gas in twenty-four hours both at 25 degrees C. and 37 degrees C.
 - (b) Cloudiness in liquid, otherwise little change of appearance.

XI. *B. violaceus*.

1. Aerobic Culture:
 - (a) Gas—None.
 - (b) Growth—Grayish.
2. Anaerobic Culture:
 - (a) Gas—None.
 - (b) No appearance of growth.

It is a significant fact that a number of ordinary aerobes produces gas in peas, a phenomenon which in so far as can be determined has been hitherto unobserved. This physiological action not only adds one more definite characteristic to the identification of these known cultures, but is suggestive that more care must be taken in the technic employed in the determination of the presence of living organisms in various types of substrata, that is, the media employed for their isolation and cultivation must simulate closely the substratum in which the organisms are living. Perhaps if Zavalla (32) and others had employed the sterile fruit or vegetable respectively from swelled cans from which the various organisms were isolated, gas production would have been obtained.

CHEMICAL ANALYSES OF CANNED PEAS INOCULATED WITH *BACILLUS A.*

Since gas production by the organisms isolated was restricted to peas it was considered desirable to prove if possible by chemical analysis that the gas was produced from the proteins of the peas.

Number 2 cans of one brand of peas were used throughout these experiments to make all results as nearly uniform as possible. A number of cans was tested to determine sterility then inoculated with *Bacillus A.* These cans began to swell in from one to two weeks after inoculation.

Two complete chemical analyses of cans so inoculated along with checks were run. As time was limited, only gas analysis, titre and pH values were carried out with the remaining cans. The contents of the cans were weighed directly. For this reason the percentage of total nitrogen would be proportionally lower as more water was present. The contents of the inoculated cans were examined carefully for appearance of decomposition. The odor was almost normal and the peas appeared no different from the uninoculated, but on mashing they were found to be softer and more watery. The juice was more cloudy and filtered rapidly, which is not true of normal canned peas due to the cooked starch present. No red color was evident in any cans although in inoculation transfers were made from a culture producing a deep red color. The taste of the peas was that of overripe peas, i. e., they lacked sweetness and had a somewhat flat taste. This was not prominent, however.

There are several points of note in connection with the results from these analyses. In the gas analysis, the low percentage of oxygen in each case suggests that in gas production an organism otherwise aerobic may obtain oxygen for its own growth under nearly anaerobic conditions. The increase of ammonia in both peas and juice, and the

increase in creatinin in the peas alone, prove without question the decomposition of protein.

It is also of note that normal canned peas have the pH value of 7.0 or neutrality but titrate .03/N. Where the cans have been inoculated an increase in acidity is shown both by titre and pH. The formation of ammonia and the presence of buffers such as protein and amino acids would of course prevent to some extent a large decrease in pH.

The results are given in the following table:

CHEMICAL ANALYSIS OF CANS OF PEAS INOCULATED WITH BACILLUS A. AND CONTROL CANS.

Can.	Gas.	Per cent Ammonia.		Per cent Total Nitrogen.		Mg. Creatinin per gram of peas.	Titre.	pH.
		Juice.	Peas.	Juice.	Peas.			
(1) (Good peas).....			.0062		.5965	.0752	.03/N	7
(2) (Good peas).....		.0289	.04257	.3271	.7064	.0398	.03/N	6.6
(3) Inoculated with Bacillus A...	Total 5 c. c. CO ₂ 48.0% H ₂ 30.0 O ₂ 16.0? N ₂ and other gases 6.0	.0777	.0525	.3376	.6820	.3119	.032/N	5.7
(4) Inoculated with Bacillus A...	Total 287 cc. CO ₂ 61.2% H ₂ 32.0 O ₂ 3.0 N and other gases 3.8	.0626	.03675	.4464	.5651	.2089	.074/N	6.2
(5) Inoculated with Bacillus A...	Total 60 cc. CO ₂ 52.27%						.006/N	4.7
(6) Inoculated with Bacillus A...	Total 75 cc. CO ₂ 47.5% H ₂ 40.0 O ₂ 4.16 N and other gases 8.34						.098/N	4.7

DISCUSSION OF RESULTS.

This work upon spoiled canned peas has necessarily been limited. For more complete data bacteriological examinations should be made of a large number of cans processed by the several methods and the work should be carried on for several seasons. This has been impossible in the present instance. However, some very definite conclusions may be drawn.

Since the organisms found in this investigation resemble *B. subtilis* and other soil organisms, it is reasonable to suppose that all are from that source. The means of contamination may have been from one or

all of several sources. Soil or dust on the pods may have been transferred to the peas in shelling; there may have been dirt on the hands of those shelling the peas which would be transferred to the peas; peas dropped upon the floor, if picked up later would add their quota to the organisms already present; dust from the air may have settled upon the shelled peas in the room or refrigerator when left over night, this incubation period giving an opportunity for any bacteria to multiply to a greater or less extent as favorable moisture and temperature conditions obtained. As the peas shelled and canned the same day showed a much lower percentage of spoilage than peas partly shelled and left until the next day before canning, this last method of contamination, at least in so far as an incubation period is furnished, would seem an important one.

The percentage of spoilage was much lower in pint cans of peas autoclaved than in the same size cans processed by any other method. This doubtless accounts for the higher percentage of spoilage of home canned peas as they are usually canned by the hot water bath method, in contrast to the commercially canned product. The results tabulated in Table I suggests strongly that one hour is much too short a processing period in the autoclave for peas canned in the quart size mason jars.

The commercial canner is especially careful to have his peas canned as soon as possible after cutting. He is also very thorough in washing the product before canning. Doubtless, cleanliness is the secret of the low percentage of spoilage as his process consists of heating the cans at 112-115 degrees C. for 35 to 40 minutes, a temperature withstood by the organisms described in this paper.

The ability to form gas in peas seems to be due to the action of organisms upon some protein or proteins found in peas and not in artificial media. It may be possible to differentiate further between similar organisms by the use of peas or like plant products as a medium since organisms not classified as gas formers were found to produce gas when so tested.

SUMMARY.

1. The lowest percentage of spoilage was found in peas processed in the autoclave.
2. Peas canned immediately after shelling had a comparatively low percentage of spoilage.
3. Organisms found were all spore forming bacilli.
4. All organisms withstood from ten to fifteen pounds pressure in the autoclave for ten to twenty minutes.
5. Nearly all organisms reduced starch to sugar.
6. Seven of these organisms caused peptonization in milk.
7. But one organism found failed to produce indol from peptone.
8. Eight of the organisms found in canned peas produced gas in sterile peas but not in other media.
9. *B. subtilis*, *B. ramosus*, *B. ruber*, *B. prodigiosus*,* and *B. viscosus* produced gas in peas but not in other media. This fact suggests additional possibilities in differential identification tests.

*Gas production in sugar broth fermentation tubes has been noted with at least one strain of an organism which otherwise very closely resembles *B. prodigiosus*. (F. L. Rector)

CONCLUSIONS.

The spoilage in cold packed canned peas is largely due to the presence of resistant spore-forming organisms which are not killed by the temperature attained in the prescribed method for processing. Therefore, before canning peas or other vegetables, the product should be very carefully washed to remove all soil or dust and thus remove the greater percentage of organisms.

The time for processing of vegetables should be lengthened so that the center of the can may be at a high temperature sufficiently long to kill the more resistant organisms.

The processing of all cold packed canned vegetables should be carried out by the steam pressure method to insure the greatest probability of success.

The results obtained in the chemical analysis of spoiled peas suggest that the determination of creatinin and ammonia, especially the former, may serve to detect bacterial decomposition in this canned food product.

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FOREWORD.

The present paper, dealing with the genus *Laccanium* in Michigan, and in bordering states, is the result of collections made during a long period of years. It is hoped that it may furnish something of value to the student engaged in the study of coccids, and make more easy the accurate identification of species of economic importance, in order that the results of control experiments may be more exact.

LECANIUM.

Technical Bulletin No. 48

By R. H. Pettit and Eugenia McDaniel.

The genus *Lecanium* includes forms of Coccids having each an anal cleft at the base of which is placed a pair of small triangular plates known as the anal-plates. The form may be flat or almost spherical, the color is usually brown but may be quite brilliant and conspicuous in some forms. The young may be produced alive or eggs may be laid which remain under the body of the mother until hatching time. The skin may be shiny or dull, naked or clothed with a thin sheet of waxy material or with a waxy secretion resembling cotton or meal, but in no case is the wax in the form of plates as in *Ccroplastes*, or are the eggs laid in a nidus of cottony material pushed out behind the insect as in the case of *Pulvinaria*.

The only characters apparently thus far discovered for separating the members of *Lecanium* into species, lack stability. This naturally accounts for the multitude of species recorded; too many of the workers contenting themselves with insufficient exploration or else becoming discouraged and publishing their impressions at the time of dropping the group.

The members of what we consider *L. corni* find themselves distributed over a multitude of host-plants and seem to thrive under various climatic conditions. They vary in size, shape, color and somewhat in derm markings, characters of the anal-plates, and in the antennal characters. The appearance of the derm seems to be influenced strongly by the age of the subject, by the method of its preparation, and by the time of boiling. Also there is a variation among individuals which is of course, to be expected. Just what are the limits of variation between species, and just where we shall cease to regard individuals as merely differing one from another, and to consider them as different races; just where races merge into varieties, and varieties into species, must, as yet, be a matter of individual opinion, and must remain so until some one finds characters of a more stable nature on which to divide the members of this puzzling and baffling genus.

It would seem that the peculiar tessellations so conspicuous in the derms of some examples are of less value than was anticipated, since their appearance depends, more or less, on the age and vigor of the individual specimen and on the preparation of the mount.

In order to examine the anal-plates and the derms of *Lecania*, it is necessary to clear the specimen and often desirable to make permanent mounts. We have found the following method fairly satisfactory for this purpose:

First, specimens, either fresh or dry, are boiled in 10% sodium hydrate (caustic soda) until they begin to show a slight bleaching. They are then boiled in one or two changes of distilled water, until

it is thought that all the soda is eliminated, after which they pass into weak alcohol and from that to strong alcohol. Some of the specimens are placed for a short time in 95% alcohol saturated with magenta, which aids greatly in bringing out derm markings. Finally they are placed without rinsing in chloroform and allowed to stay there for an hour or more, to be finally mounted under pressure in raw balsam and dried with gentle heat.

Photo-micrographs of the natural browns and yellows are made with the aid of a blue color screen (Wratten No. 45) and those stained magenta, usually come out better when a green screen is used. (Wratten No. 58).

The works of Messrs. Wm. B. Thro, J. G. Sanders, E. Ernest Green and Robert Newstead of the more recent writers have been used freely in the attempt to place the different forms. Thanks are due to Dr. G. D. Shafer, Palo Alto, California, to Prof. C. W. Woodworth of the University of California, to Professor J. G. Sanders of the Penn. Department of Agriculture, to Mr. Huber Hilton, Supervisor in the Forestry service, to Mr. F. G. Kilp of Trout Lake, Wis., and to Mr. E. O. Essig of the University of California for coecid material, also to Prof. Glenn Herrick of Cornell University, for securing the loan of type material of *L. obtusum* of Thro, for study.

All the forms have been included under the name *Lecanium*, because the various sub-genera proposed seem to grade into one another too closely to render profitable any attempt to separate them until some one revises the genus as a whole. It is believed that a study of the American species of this genus will result in a marked reduction in the number of species.

It is felt by the writers that this bulletin is from necessity incomplete, for the reason that further collecting will undoubtedly yield more species, therefore the writing of a key has been deferred until a later date.

LECANIUM (Toumeyella) CORRUGATUM Thro.

A medium sized *Lecanium* on Pine. The females often crowded together on the twigs, while the males occupy the leaves. Male scales rather slender and delicate, having the usual ridges. Females reaching $1/5$ inch in length; shape somewhat globular unless distorted by crowding, which tends to make them more elevated and irregular in outline. Color brown; surface wrinkled.

When boiled in caustic soda, the liquor is stained a red-brown. In region of anal-plates there are scattered a number of circular gland-pores and all over the derm are irregular clear spots each with a dark dot inside. Antennae of three joints, vestigial in type.

Anal-plates triangular, with angles rather abrupt. There is one fringe seta on each side. Dr. Thro* describes two. No doubt individuals may be found with two. There are four sub-apical setae on ventral surface, and three apical setae on dorsal surface, on each side. There are also four or five hypopygial setae on each side extending in a curve from the fringe seta forward to near the median line. The spiracular setae are placed three in a group, the middle one being

* (Bul. 209 Cornell University Exp. Sta.)

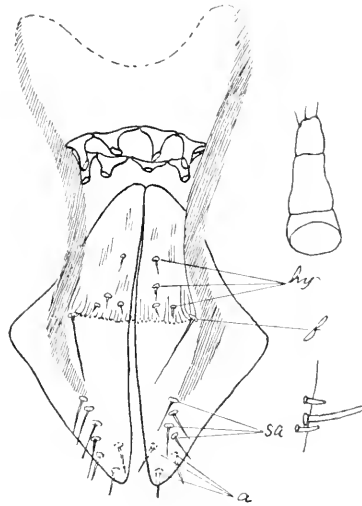


Figure 1.

Lecanium corrugatum.—Antennae, spiracular setae, and ventral view of anal plates; hy, hypopygial setae; sa, sub-apical setae; a, apical setae, the last named on dorsal surface.

much longer than the outer two and curved. The two smaller ones being conical.

This species was collected by the senior author at Ithaca, New York, on Scotch-pine. And it has been received on Scotch-pine from Saginaw, N. C. It is also recorded on Austrian-pine.

LECANIUM (*Toumeyella*) CORRUGATUM VAR. NEGLECTUM n. var.

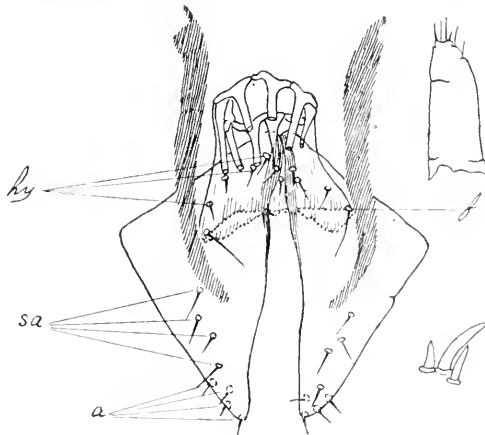


Figure 2.

Lecanium corrugatum var. *neglectum*.—Antenna, spiracular setae, and ventral view of anal plates; f, fringe seta; hy, hypopygial setae; sa, sub-apical setae; a, apical setae, the last named on dorsal surface.

Closely related to *Lecanium corrugatum* is a variety collected at Ithaca, N. Y., on Pitch-pine. It differs from the typical *corrugatum* in the possession of four apical setae on the dorsal surface of each anal-plate or at its margin; in the sharply acuminate spiracular setae, and in the comparatively shorter chitinous thickenings that extend forward from the ventral surfaces of the anal-plates. There is in front of the anal-plates a group of strongly marked small round structures which show their conical form when viewed from the side.

LECANIUM (*Toumeyella*) NUMISMATICUM sp. nov.

A species on Scotch-pine collected at Tront Lake, Wisconsin, on 15 November, 1919, and sent in by Mr. Huber C. Hilton of the U. S. Forestry Service. At this time the insects were adults but not of full size. The females evidently winter as half-grown imagines. The male puparium is 1/16 inch long, the customary longitudinal and transverse ridges being practically absent,—the entire male pellicle being translucent, almost transparent and hyaline. The male scales are placed usually on the twigs with the females, although a few are on the leaves.

Females about 1/8 inch long in November, in color, cherry-red to reddish-brown, covered by a coat of thin, hyaline wax; skin much wrinkled. Later the females turn brown and become a little larger. The form inclines to rotund except where crowded into clusters of superimposed individuals. Around the anal-plates and sometimes on

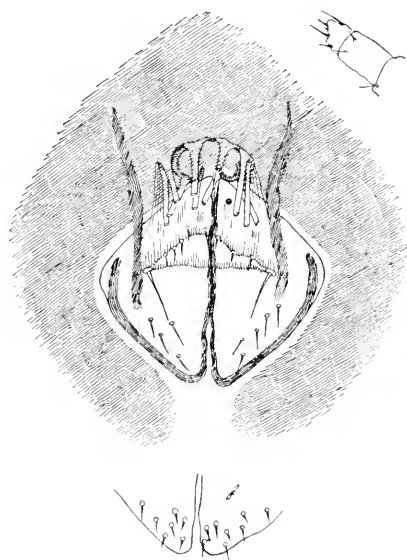


Figure 3.

Lecanium numismaticum.—Antenna; and ventral view of anal-plates together with the chitinous border surrounding them; b, dorsal view of tips of plates showing the apical setae.

other parts of the body in fresh living specimens are found flakes of snow-white wax.

On the ventral surface there is a patch of setae cephalad of anal-plates, also there are numerous round gland-pores cephalad of setae on derm in region of plates, in fact, these round pores obscure the characters of the plates and suggest coins strewn over the surfaces to be studied.

The anal-plates are somewhat rounded at lateral angles and not sharply pointed at caudal angles. Cephalo-lateral and caudo-lateral margins slightly curved outward. Each plate is bordered by a chitinous thickening down its mesal margin, which thickening is continued around the apex, up the caudo-lateral border nearly to the lateral angle where it curves slightly inward from the margin for a short distance. There are on each side, one fringe seta, and four or five sub-apical setae on the ventral surface, and from five to eight apical setae on dorsal surface of each plate. There are also eight or more hypopygial setae, four or more on each side. In some cases there are two fringe setae on each side.

There are ten spines in the anal-ring. There is a chitinized area around the anal-plates; this area is variable in form in specimens collected in November.

Antennae three-jointed; vestigial in type. Spiracular setae not observed; feet tiny, vestigial.

LECANIUM (*Neolecanium*) CORNUPARVUM Thro.

Female large and elliptical, sometimes reaching nearly half an inch in length. Specimens range from flat to elevated, depending on surface of bark. Color seal-brown with varnished surface, marked with oval maculations of lighter yellowish-brown. Surface dimpled, dusted with waxy bloom. In caustic soda the liquor becomes rich mahogany-

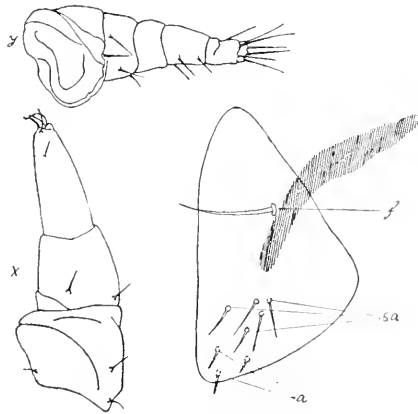


Figure 4.

Lecanium cornuparvum.—Antenna; leg; and ventral view of one anal-plate; f, fringe seta; sa, sub-apical setae; a, apical setae, the last named on dorsal surface.

brown. Derm thickly dotted with pores appearing as oval, pellucid areas each enclosing a dark dot. Immediately in front of the anal-plates is an area marked with many round gland-pores forming a large cluster which is ill-defined, the round pores thinning out and occurring scattered among the more plentiful ordinary type of pores which occur all over the body.

Antennae five or six-jointed, short, conical and of vestigial type. Legs also short and thick.

Spiracular setae not observed, but described by Dr. Thro as short, stout, and in groups of three, sub-equal in length and about one-half as broad as long with the median seta notched at apex. Marginal setae short and conical.

Anal-plates with cephalo-lateral margin longer than caudo-lateral; angles rounded, each plate bearing one fringe seta; five or six sub-apical setae and three apical setae, the latter placed on the dorsal surface. Sometimes there is also an added apical seta on the ventral surface and sometimes there are only two dorsal apical setae. The sub-apical setae vary somewhat in position. There are present a number of hypopygial setae which are not represented in our figure because of distortion in the specimens available. Anal-ring has ten spines.

The specimens studied came from Orwell, Ohio, having been collected by the late Professor E. E. Bogue from cucumber-tree.

LECANIUM (*Toumeyella*) *LIRIODENDRI* Gmel.

First reported on tulip-tree from Michigan by Dr. Cook in 1878. The material from which our drawings were made came from Connecticut in 1890 and was determined by Dr. Cook as *Lec. tulipiferae*.



Figure 5.

Lecanium liriodendri.—l, leg; b, antenna; sp, spiracular setae; and ventral view of anal-plates; f, fringe setae; sa, sub-apical setae; a, apical setae, the last named on dorsal surface.

Male puparium thin, waxy, wrinkled somewhat and broad, but not differing otherwise markedly from the common type of puparium.

Adult female in dried specimens brown, naked, somewhat wrinkled and of large size. Some measuring more than 1/4 inch long, round-oval and elevated; in our specimens the form is distorted owing to their being crowded into groups.

Derm not strongly chitinated except that there is often in old specimens a horseshoe shaped area of thick, brown chitin partially surrounding and bordering the anal-plates. In front of this area or just in front of (cephalad of) the anal-plates are a large number of small round pores scattered thickly on the dorsal surface. On the ventral surface just under the dorsal pores are many small, transparent spines, varying in size.

In caustic soda there is given off a reddish-brown color during boiling.

Antennae short, blunt and reduced to small size. Legs short and stumpy. Marginal setae small, regular and numerous. Spiracular setae very short and stout.

Anal-plates with rounded angles, cephalo-lateral margins nearly straight. Caudo-lateral margins curved. Anal-ring with 10 long setae.

On each side there are two fringe setae and five sub-apical setae. On dorsal surface there are three apical setae arranged in a triangular position. There are also five or six hypopygial setae extending cephalomesad from each pair of fringe setae.

Found on Tulip-tree. There is but one annual generation, the young being born in the autumn according to Dr. Britton,* the females being partially grown when winter sets in. As a rule the lower branches are first attacked and killed. Dr. Britton also records this scale on Magnolia and on Linden.

LECANIUM (*Eulecanium*) CARYAE Fitch.

Mature females large, and oval in form, flat, or less commonly elevated, the cephalic third usually broader than the rear two-thirds. The color is mahogany-brown. Anal-cleft deep and conspicuous. The anal-plates are proportionately small. Surface wrinkled, usually varnished, covered with waxy, pruinose coat, specimens often half an inch long and when on large limbs, quite flat. On small limbs they are apt to be more elevated and of smaller size.

Derm over the entire body marked by pores. Antennae six or seven-jointed with joint three much the longest. Marginal spines large and forming a conspicuous row about the body, spiracular setae not present in any specimens thus far observed. Ano-genital ring with eight spines. Anal-plates not very strongly chitinated and apt to be wrinkled, in younger specimens the caudal angle is apt to be rounded, although, in older examples this angle appears more pointed. There is a distinct V-shaped notch formed at the cephalic angles of each pair of plates.

The setae of the anal-plates seem to be variable in number and position. On each side there is one fringe seta; three sub-apical setae which may be placed either near the margin or in some cases in their normal location; an apical seta at the extreme apex of the plate, some

*State Ent. of Conn., 12th Rep., p. 294.

times two placed close together. Sometimes the fringe setae are doubled, there being a pair of spines instead of a single individual. Besides these there are on the dorsal surface of each plate, three short tack-like spines on the mesal border of the caudal quarter. There are also four hypopygial setae.

This species has been found on Blue-beech, Elm and Birch at Ithaca, N. Y., on Blue-beach, Elm and Black willow at East Lansing, Michigan, and on Peach at Covert and at South Haven, Michigan.

It can easily be distinguished from *L. cornuparvum*, which it superficially resembles by the well developed antennae, by the presence of eight setae in the anal-ring and by the setae on the dorsal surfaces of the anal-plates.

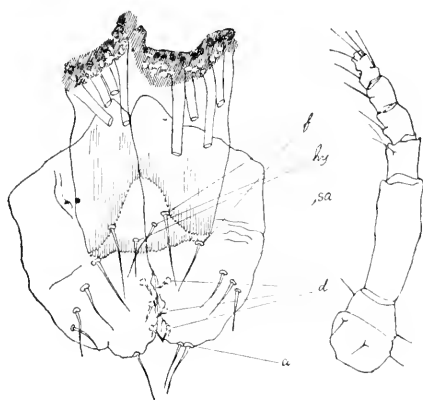


Figure 6.

Lecanium caryac.—Antenna; and ventral view of anal-plates; f, fringe setae; hy, hypopygial setae; sa, sub-apical setae; a, apical setae; d, setae on dorsal surface.

LECANIUM (*Eulectanium*) CORNI. Bonché.

The full-grown females are yellowish-brown marked with darker when just grown, later turning dark-brown and being covered with a powdery or cottony material which resembles the bloom of a plum. They are oval in form and in general elevated, although the size and form are more variable than in any other species known to us. The full grown females measure from 1/8 to 3/16 inch in length. The white eggs are laid under the bodies of the mothers during May, later the eggs become pinkish and hatch in late June. The young from these eggs crawl about for a time on the leaves. In late August the small insects migrate back to the twigs and there hibernate, completing their growth in the spring. There is but one generation each year.

The scales of the males are of the usual delicate, almost transparent, wax with well marked ridges.

The females, when prepared by boiling in caustic soda, show antennae usually of seven joints, with joints three and four the longest, sometimes joints three and four are united making a six-jointed antenna.

The anal-plates vary considerably in form but usually the lateral and apical angles are rounded. There are on each side two fringe setae, two sub-apical setae and four apical setae, the latter variably placed. The most common arrangement being three on the dorsal surface near the apex of the plate, forming a triangle, with the fourth seta slightly in front of the other three and on or near the mesal margin of the plate. Sometimes this latter seta is set well back from the mesal margin on the dorsal surface and sometimes to a lesser distance on the ventral surface. Sometimes the three that form a triangle are placed on the margin and more rarely near the edge on the ventral surface.

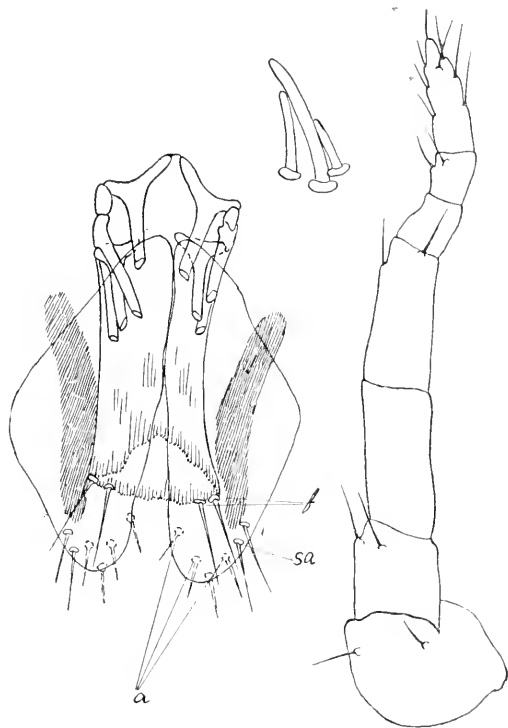


Figure 7.

Lecanium corni on maple.—Antenna; spiracular setae; and ventral view of anal-plates; f, fringe setae; sa, sub-apical setae; a, apical setae, the last named on dorsal surface.

There are clusters of gland-pores near the spiracular setae and often large clusters cephalad of the anal-plates. Often strings of these round gland-pores extend from the spiracular setae to the spiracles. These seem especially numerous in specimens collected on Basswood and on Bittersweet, also on those collected on Ash, Hawthorn, *Cornus* and White Oak. These gland-pores are most conspicuous in young specimens. Sometimes they almost disappear as the derm thickens with age.

The chitinized derm shows many pores appearing as transparent irregular openings in the chitin usually arranged somewhat radially.

Spiracular setae in groups of three with the middle one longer, and all with rounded apices. Anal-ring with eight spines. Marginal spines rather feebly developed in mature specimens.

We are unable to differentiate *Lec. armeniacum*, *L. fletcheri* or *Lec. obtusum* from *L. corni*.

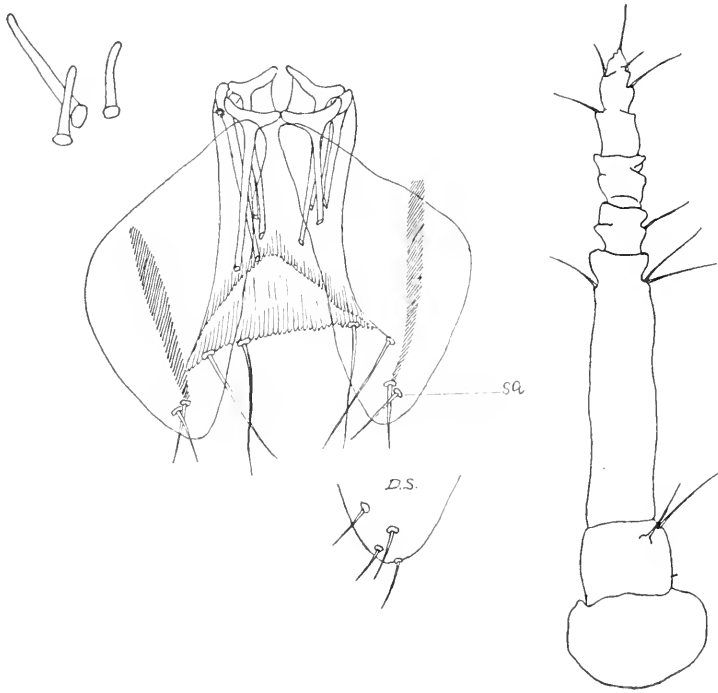


Figure 8.

Lecanium corni on tulip-tree.—Antenna; spiracular setae; and ventral view of anal-plates; S.A., sub-apical setae; D. S., dorsal surface of tip of anal-plate showing apical setae.

This species has been studied on material collected at East Lausing on Maple, Plum, Japanese-plum, Bitter-sweet, Grape, Soft-maple, Tulip, Elm, Hickory, *Euonymus atropurpureus* (Burning bush), Wild-cherry, Pea-tree, Blue-beech, Cucumber, Willow (*Salix nigra*), Buckeye, White-oak, *Magnolia acuminata*, Prickly-ash, Sycamore, Beech (*Fagus*), *Crataegus*, Sassafras, Black-berried-elder, Ironwood, Basswood, Honey-locust, Red-elm, White-ash, Butternut, Black-ash, Blackberry, *Celtis occidentalis* or Hackberry, cultivated Currant, and Quince.

And from other parts of Michigan in addition on Black-walnut, Black-locust, Peach, Red-ash, Black-oak, Hickory, Green-ash, European Linden, Rose, Juniper and White cedar.

LECANIUM (*Eulecanium*) NIGROFASCIATUM Pergande.

Female reddish-brown, oval or pear-shaped. Elevated nearly half its breadth. From $1/8$ to nearly $3/16$ inch long. The top of the female is lighter in color than the sides. There are about twelve radiating lines

extending to the outer edge on each side, the spaces between being darker, the dorsum being darker both in front and in the rear. The surface is shiny, smooth and covered with a delicate, thin coat of wax. The winter is passed in a nearly full-grown condition. In her excellent account of the life-history of this scale, Miss Murtfelt speaks of the color as bright sealing-wax red with brown and black, at the time when just acquiring full-size. These bright colors disappear as the scale dries with age. In the spring the growth is completed and eggs are laid from which nymphs attain nearly full growth by the following autumn, there being but one annual generation.

Specimens boiled in caustic soda show a rather clear derm with feeble chitonization.



Figure 9.

Lecanium nigrofasciatum.—Antenna; spiracular setae; foot; gland-pores and ventral view of anal-plates; sa, sub-apical setae; a, apical setae, the last named on dorsal surface.

The antennae are slender, six-jointed, the third joint being much the longest. From the anal-plates, there extends cephalad a row of round gland-pores, two-thirds of the distance to the cephalic margin, and there is also a group of smaller pores scattered about each group of spiracular setae. The marginal setae are not numerous, they are small, slender and sharply pointed. Spiracular setae in groups of three with the middle one much the longest and with rounded ends. The anal-plates have rounded angles, the cephalo-lateral margin being longer than the caudo-lateral. There are present on each side two fringe setae, the outer one being longer; two sub-apical setae, and three apical setae, short and inconspicuous on the dorsal surface of each plate.

Surrounding the anal-plates is a conspicuous, chitinized border, narrow and forming a frame around the plates.

The species is common in Michigan on Peach, and Red maple, it is also found on Plum, *Prunus simonii*, Sugar maple, *Acer pseudo-platanus*, *Crataegus*, Sycamore, *Bromelia*, Basswood, *Benzoin* and Birch.

LECANIUM (*Eulecanium*) PRUNASTRI Fonsc.

A small globular species of *Lecanium* mentioned by Mr. J. G. Sanders, State Economic Zoologist of Pennsylvania, as occurring on Apricot, Peach and Sweet cherry, is included here because of the likelihood of its occurrence in Michigan sooner or later.

Mr. Sanders very kindly has furnished us material for study, but we have been unable to prepare satisfactory mounts thus far, due in part to the globular form of the insect and to the stage in which it was collected. Mr. Sanders mentions in his description, the derm-pores extending in a large oval patch cephalad of the analplates. Our figure shows this patch in a specimen obtained from Dr. Sanders.

While the material did not yield good mounts for a drawing, the following characters seem to be apparent:

Ten spines in the anal ring, two of them slender, one being sometimes *very* slender so that there appear to be only nine at times. There are about twelve hypopygial setae, long and slender, three apical setae, and two or more sub-apical setae. There seem to be two fringe setae on each side.

Antennae well developed, slender and of six or seven joints. Feet well developed.

LECANIUM (*Coccus*) HESPERIDUM Linn.

A common *Lecanium* in greenhouses, of oval form, usually slightly broader behind, rather flat and varying from 1/8 to 3/16 inch in length and from 1/16 to 1/8 inch broad. It is extremely variable in color,

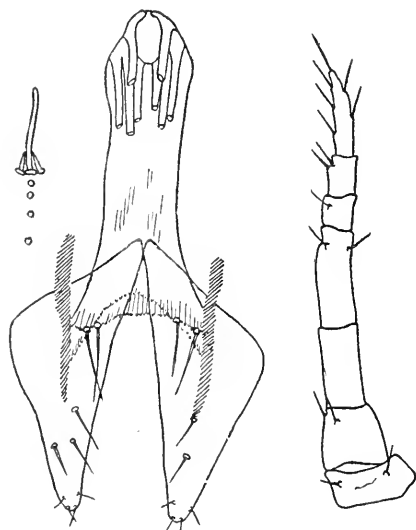


Figure 10.

Lecanium hesperidum.—Antenna; spiracular setae; and ventral view of analplates.

but red or yellowish-brown is a usual color, sometimes marked with darker hues. Often a greenish tint is apparent. It appears to have posed under a great variety of names, and is sometimes called the "soft Brown Scale."

The adult female is naked. The boiled and stained derm is marked by a few round gland-pores in the vicinity of the anal-plates and by others in rows extending from the spiracular setae to their corresponding spiracles. The derm is marked also by scattering small, round pores all over the body. Antennae usually seven-jointed, long, and slender. The anal-plates are rather narrow, the caudo-lateral margin being longer than the cephalo-lateral; the lateral angles are rounded and the caudal angles more sharply rounded. There is a small V-shaped angle at the point where the plates touch at their cephalic ends. There are usually two fringe setae on each plate, two and rarely three sub-apical setae and four small, apical setae. The anal-ring is usually situated far in front of the plates and the setae of the anal-ring are proportionally long and slender.

Spiracular setae with middle one long, slender and often curved and with the outer ones sharp, pointed and tack-like. Marginal setae slender, pointed, each borne on a button-like base, a small proportion of these setae are forked at the tip and likewise a few show a suggestion of a fringe. Anal-ring having eight long hairs.

There is a form which differs in no wise from the typical *hesperidum* in the characters of derm and plates but which is marked by a large mottled cross, sometimes by a double cross on the dorsum. It answers perfectly to the description of *L. alienum* of Douglas, so far as external appearance is concerned. It seems to be a race or a variety since numbers of these cross-marked specimens are commonly found in company, often on palms or on house rose. *L. hesperidum* lives on a great variety of greenhouse plants.

LECANIUM (*Coccus*) LONGULUM Doug.

Adult female elongate-oval, either elevated or flattened, depending on emplacement; yellowish-brown to dark-brown, sometimes reaching a length of 1/4 inch; surface smooth, marked by punctulations; antennae eight-jointed, slender. Spiracular setae with middle one curved and slender, tapering. The two outer setae being shorter and tack-like.

Derm marked by a copious sprinkling of small, round pores, feebly chitinized. Anal-plates with caudal and cephalic angles sharply rounded. Lateral angle more broadly rounded. There are four fringe setae and four sub-apical setae on each side. Three small apical setae and one discal seta on each plate, these last being on the dorsal surface.

Found only under glass in Michigan. The species used to abound in the green-houses of the Michigan Agricultural College, but for several years it has been difficult to collect since it is kept in subjection by a fungus disease, *Isaria lecanifera*.

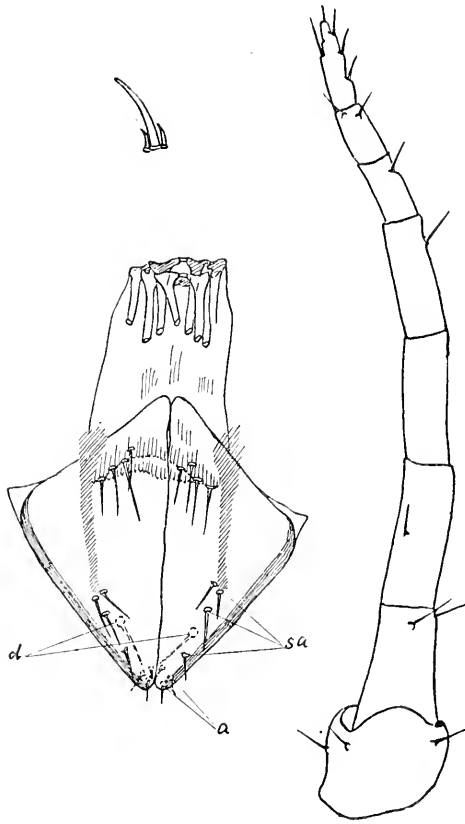


Figure 11.

Lecanium longulum.—Antenna; spiracular setae; and ventral view of anal-plates; d, discal seta; sa, sub-apical setae; a, apical setae, on dorsal surface.

LECANIUM (*Eucalymnatus*) PERFORATUM Newstead.

Female a flat, dark-colored scale of broad-oval form often $\frac{3}{16}$ inch long. The mature female almost black and marked distinctly into plates or tessellations of irregular form. The dark, chitinous shell of these plates is pierced by round transparent pores which appear to extend clear through the chitin. There is also an appearance of a grain to the plates produced by narrow streaks and dots of translucent appearance.

Antennae usually of eight joints with the line of division between joints 4 and 5 often obscure. Spiracular setae pointed with the middle one of each group of three much the longest.

The anal-plates have all three corners with abrupt angles. Anal-ring apparently with eight long hairs, often difficult to see. There are on each side two long fringe setae each borne on a papilla, three sub-apical setae, and three apical setae.

Found most commonly on palms, common in greenhouses and not readily confused with any of the other species in this region.

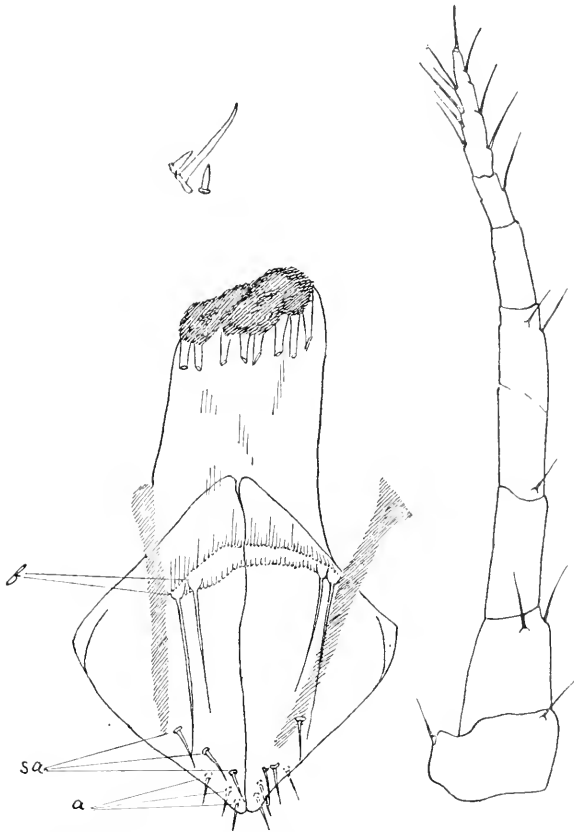


Figure 12.

Lecanium perforatum.—Antenna; spiracular setae; and ventral view of anal-plates; f, fringe setae; sa, sub-apical setae; a, apical setae, the last named on dorsal surface.

LECANIUM (*Sassetia*) OLEAE Bern.

Adult female oval in form and strongly elevated. Dark-brown or black, marked on dorsum by one median and two transverse carinae suggesting the letter H; size from 1/8 inch to 3/16 inch in length. Surface somewhat wrinkled radially; antennae slender, eight-jointed; derm marked by minute, short tubercles closely packed together. Spiracular setae with the middle one long, curved and slender while the two outer ones are short and pointed, knife-like. Anal-plates with lateral angles broadly rounded, cephalo-lateral margin much shorter than cando-lateral. Fringe setae four on each side, sub-apical setae four on each side. Apical setae small, three on dorsal surface on each plate. One discal seta on each plate.

Found only under glass in Michigan, on a variety of hosts. An important enemy of citrus fruits in mild climates.

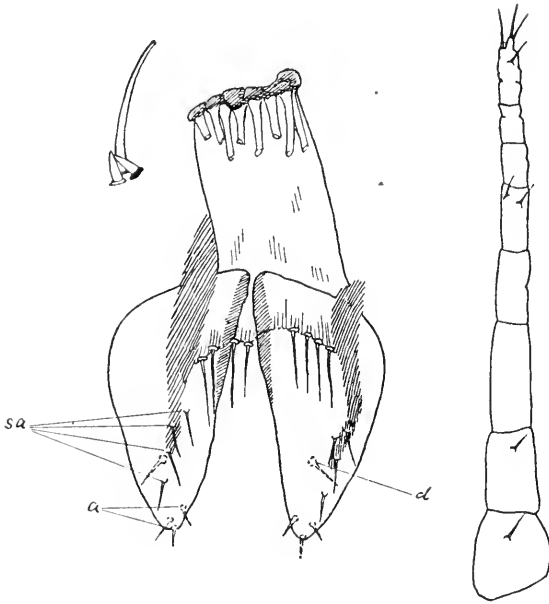


Figure 13.

Lecanium oleae.—Antenna; spiracular setae; and ventral view of anal-plates; sa, sub-apical setae; a, apical setae; d, discal seta, the apical and discal setae being on the dorsal surface.

LECANIUM (*Sassctia*) HEMISPHAERICUM Targ.

Female about 1/8 inch long, oval and strongly elevated in old examples. Smooth with the edge flaring slightly so as to rest flat on the plant. Color brown with darker mottlings. Younger specimens yellowish or dirty-white with a suggestion of a median ridge and two transverse ridges.

Derm in cleared mounts marked all over with rounded, more or less oval, clear spots. There are also many tubular glandular openings scattered over the derm. There is also a group of round gland-pores in vicinity of the spiracular setae and often a row of them extending to the spiracles themselves. Antennae slender, usually of eight articles.

Anal-plates with fairly abrupt angle at cephalic point and at lateral angles; caudal angles more rounded. Caudo-lateral margin longer than cephalo-lateral. There are three or four fringe setae, often part of them are very difficult to see. Two or three sub-apical setae, and three apical setae. There is always on each plate a prominent discal seta.

Anal-ring with eight spines. Spiracular setae in groups of three of which the middle one is long and slender, curved and either finger-shaped or sword-shaped and sharply pointed. The two outer spiracular setae pointed like daggers. Marginal setae slender, some needle-shaped but many with fringed tips and all with bulbous bases.

A common scale of green-house plants. Not found on native plants which pass the winter out of doors.

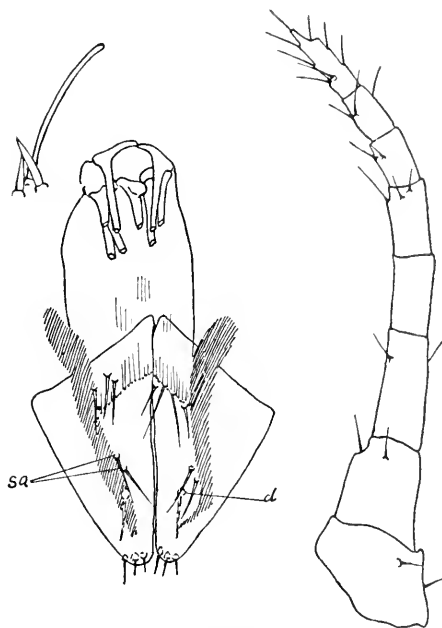


Figure 14.

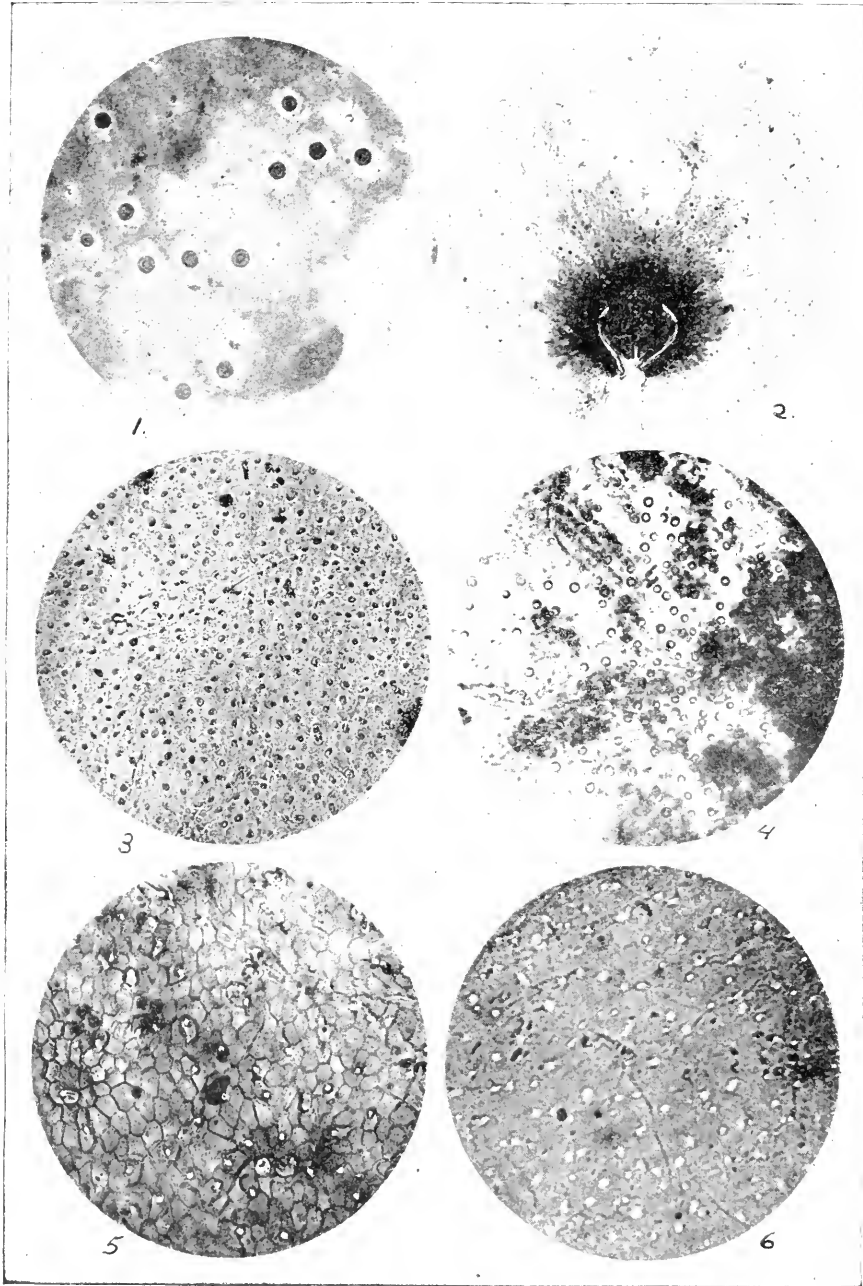
Lecanium hemisphaericum.—Antenna; spiracular setae; and ventral view of anal plates; sa, sub-apical setae; d, discal seta.



Figure 15.
Lecanium hesperidum
var. *alienum*.



Figure 16.
Lecanium hemisphaericum.
Mature females.



EXPLANATION OF PLATES.

PLATE I.

1. *Lecanium corrugatum*.—Gland-pores in vicinity of anal plates.
2. *Lecanium munisaticum*.—Anal plates and chitinized area surrounding them, also gland-pores.
3. *Lecanium cornuparrum*.—Derm markings.
4. *Lecanium liriodendri*.—Showing gland-pores cephalad of anal plates.
5. *Lecanium caryac*.—Showing tessellate cell walls especially well.
6. *Lecanium caryac*.—Showing ordinary derm markings.

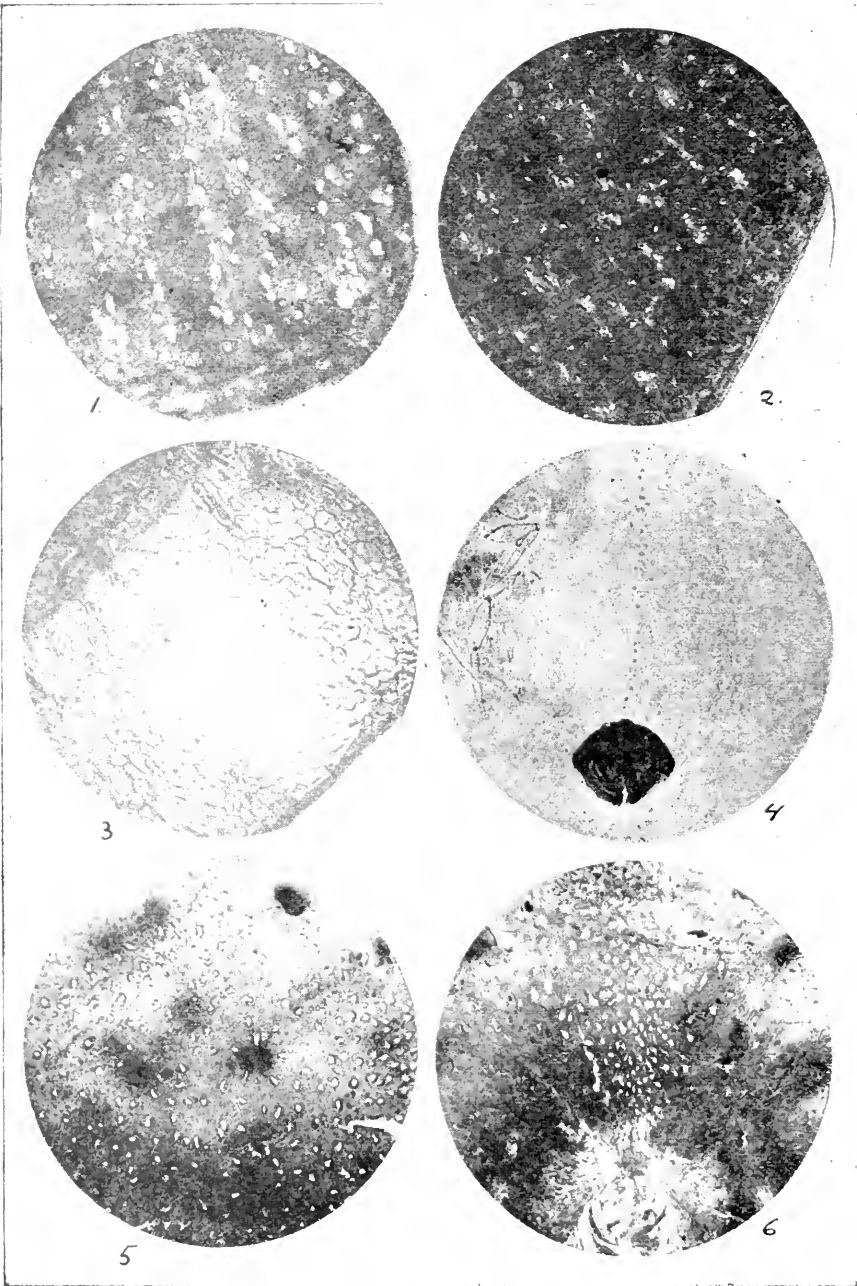


PLATE II.

1. *Lecanium corni*.—Showing ordinary derm markings; pores arranged radially.
2. *Lecanium corni*.—Old specimen heavily chitinized.
3. *Lecanium corni*.—Showing tessellate arrangement of cells frequently to be seen in certain preparations.
4. *Lecanium nigrofasciatum*.—Showing row of gland-pores arranged in row extending cephalad from anal plates.
5. *Lecanium prunastri*.—Showing derm markings; specimen from Austria.
6. *Lecanium prunastri*.—Showing derm markings cephalad of anal plates.

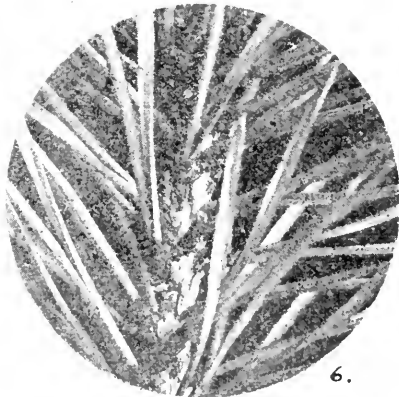
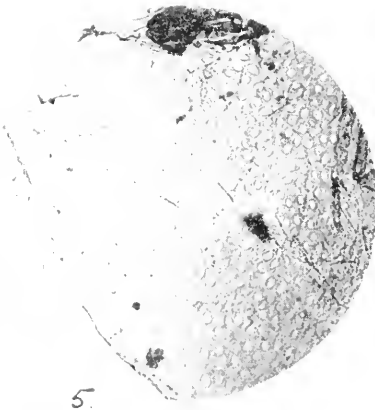
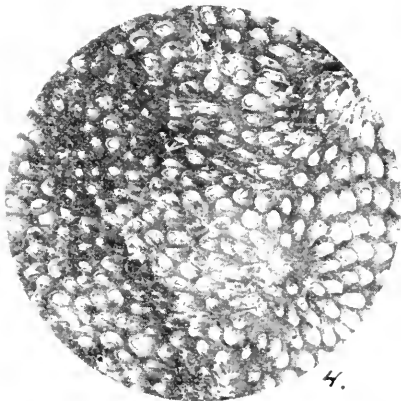
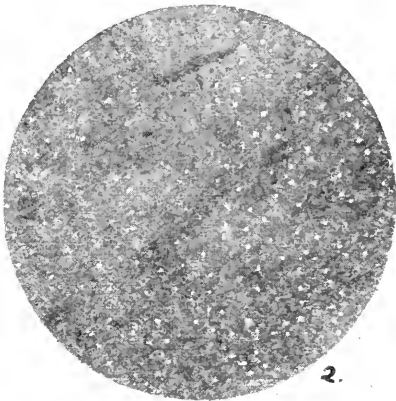
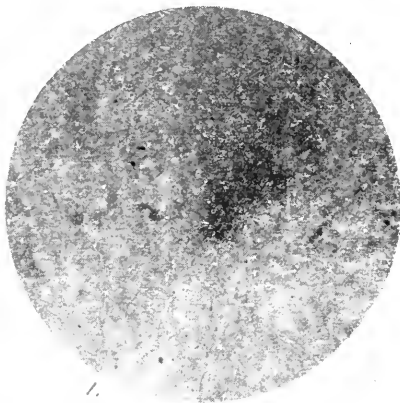


PLATE III.

1. *Lecanium hesperidum*.—Showing derm markings.
2. *Lecanium longulum*.—Showing derm markings.
3. *Lecanium perforatum*.—Showing derm markings.
4. *Lecanium oleae*.—Showing derm markings.
5. *Lecanium hemisphaericum*.—Showing derm markings.
6. *Lecanium numismaticum*.—On twig of Scotch pine, showing male and female scales.

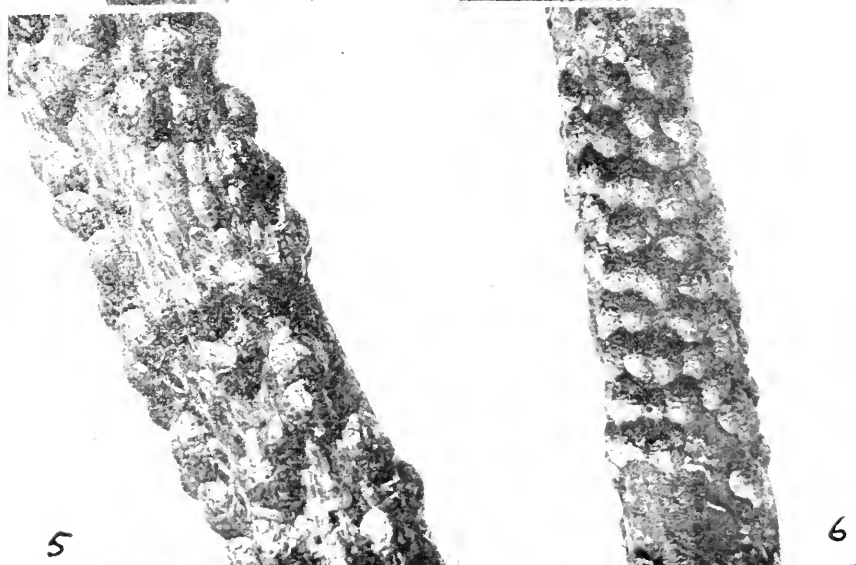


PLATE IV.

1. *Lecanium cornuparvum*.—And piece of bark from which one of this species has been removed. Slightly enlarged.
2. *Lecanium caryae*.—On elm, slightly enlarged.
3. *Lecanium caryae*.—On peach, enlarged about twice.
4. *Lecanium caryae*.—On blue beech, enlarged about three times.
- 5 and 6. *Lecanium nigrofasciatum*.—Enlarged.

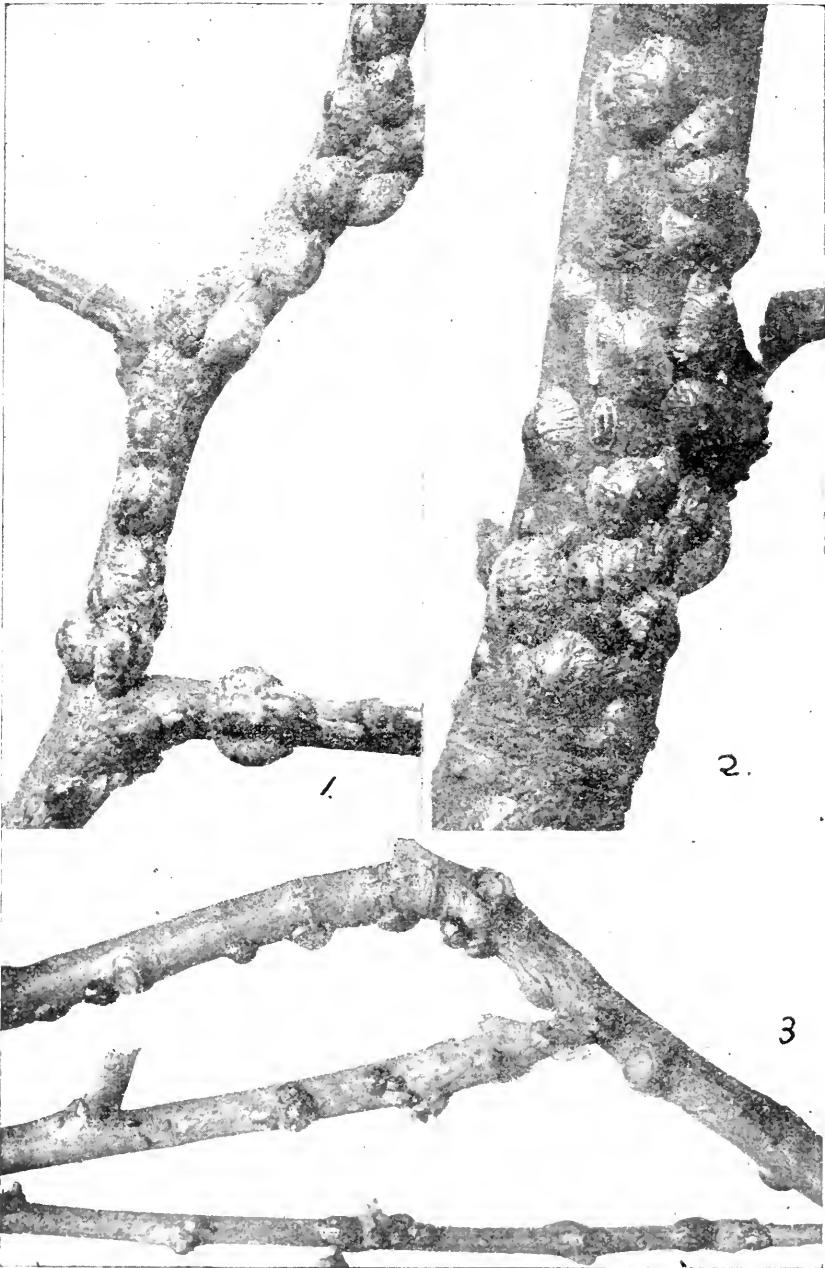


PLATE V.

1. *Lecanium corni*.—On hackberry, enlarged.
2. *Lecanium corni*.—On plum, enlarged.
3. *Lecanium corni*.—On willow, enlarged.

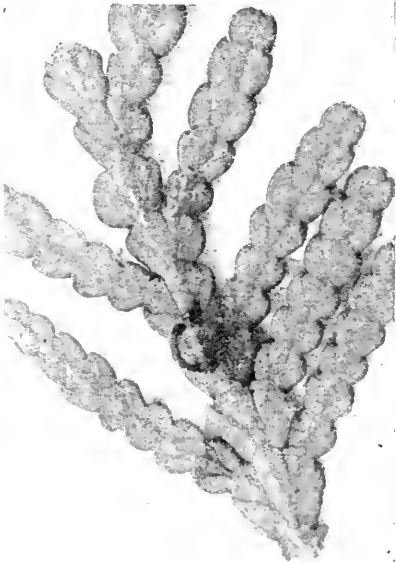
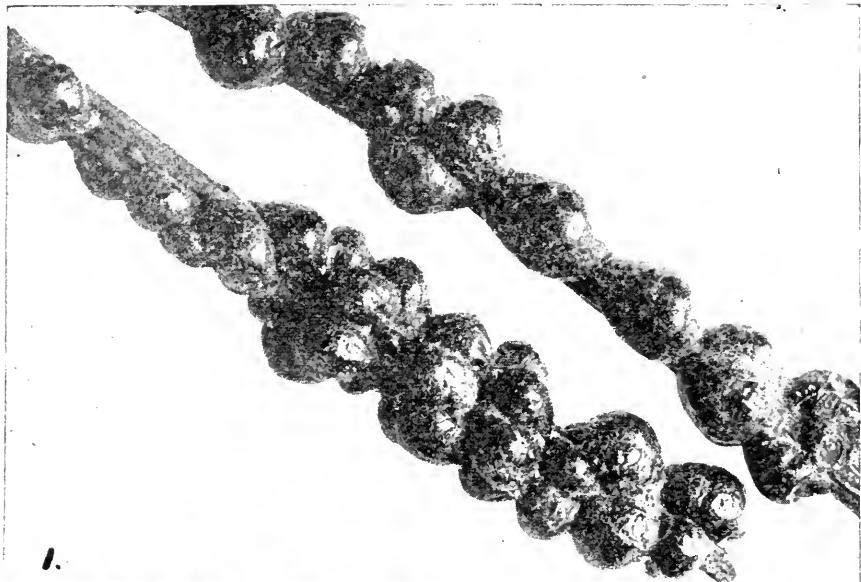


PLATE VI.

1. *Lecanium corni*.—On oak, enlarged.
2. *Lecanium corni*.—On hickory, enlarged.
3. *Lecanium corni*.—On arbor-vitae, enlarged.

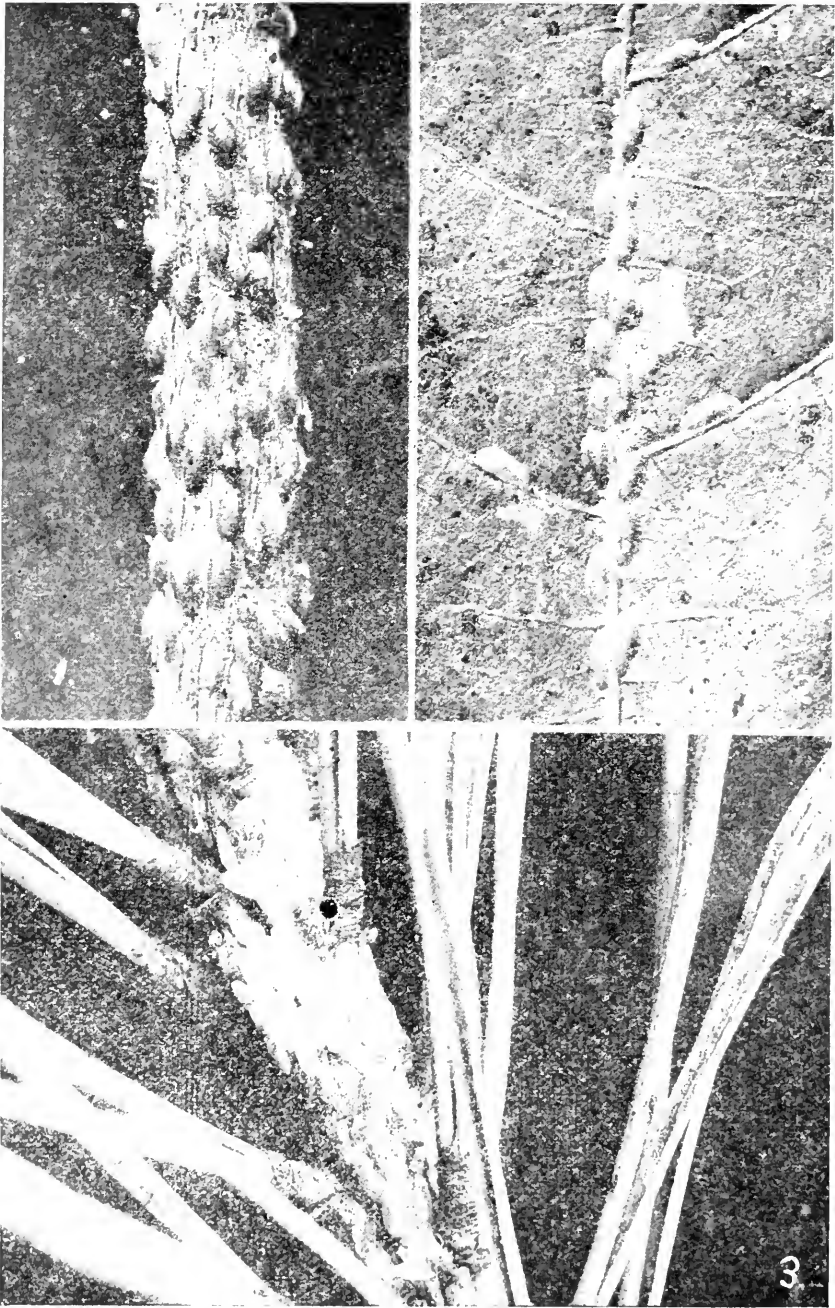


PLATE VII.

- 1-2. *Lecanium longulum*.—On fig. enlarged.
3. *Lecanium numismaticum*.—On Scotch-pine, enlarged.

INDEX

A.

	Page
Account, current, July 1, 1919, to June 30, 1920	20-21
Account for fiscal year ending June 30, 1920, experiment station	23
Account for fiscal year ending June 30, 1920, extension	24
Account of Michigan Agricultural College for year ending June 30, 1920	16-40
Account, treasurer's	17
Administrative committee, cooperative extension work in agriculture and home economics	13
Agricultural education, report of the department of	55
Agricultural experiment station council, members of	13
Allen scholarship, George L.	19
Alumni recorder, report of the	124
Analysis of commercial fertilizer	442
Analysis of feeding stuffs for 1918-1919	330-399
Animal husbandry, report of the department of	50
Animal husbandry, report of the section of	230
Animal pathology, report of the department of	81
Animal pathology, report of the section of	287
Annual report and audit and examination, Michigan State Agricultural Society	203
Annual report of the experiment station, Michigan Agricultural College	227
Annual report of the liberal arts council	137
Apiaries, report of the state inspector of	103
Appropriations, distribution of special	22

B.

Bacteriology, report of the department of	90
Bacteriology, report of the section of	231
Botany, report of the department of	94
Botany section, report of the	262
Boys' and girls' club work, report of	194
Boys' and girls' club work, specialists in	15
Bulletin No. 287, fertilizer analyses	435
Bulletin No. 286, studies in cost of milk production	400

C.

Chemical section, report of the	267
Chemistry, report of the department of	95
Circular No. 41, state laws governing the protection and planting of street trees	563
Circular No. 42, short season hay crops	571
Circular No. 43, increasing the production of the bearing apple orchards	574
Civil engineering, report of the department of	59
College inventory, June 30, 1920	38-39
Commercial feeding stuffs	311
Cooperative extension work in agriculture and home economics, administrative committee	131
County agricultural agents, list of	14-15
Current account, July 1, 1919-June 30, 1920	20-21

D.

Dairy husbandry, report of the department of	45
Dean of agriculture, report of the	41
Dean of engineering, report of the	57
Dean of home economics, report of the	72
Detroit commission plan of city milk administration, special bulletin No. 99	520
Director of the experiment station, report of the	229
Directions for making a good flavored cider vinegar, special bulletin No. 98	495
Disbursements of experiment station moneys other than received from U. S. treasurer	228
Disbursements on account of U. S. appropriation of experiment station moneys	228
Distribution of special appropriations	22
Drawing and design, report of the department of	67

E.

Economics, report of the department of	105
Electrical engineering, report of the department of	66
English and modern languages, report of the department of	96
Entomological section, report of the	275
Entomology, report of the department of	102
Experiment station moneys, disbursements of	228
Experiment station, report of secretary and treasurer	228
Experiment station workers, list of	12
Extension schools and farmers' meetings, report of	158
Extension specialist in dairying, annual report of	168

	Page
Extension specialist in poultry, report of	181
Extension specialists	14
Extension work in apiculture, report of	177
Extension work in entomology, report of	176
Extension work in farm crops, report of	164
Extension work in forestry, report of	178
Extension work in home economics, report of	183
Extension work in horticulture, report of	170
Extension work in muck crops, report of	174
Extension work in poultry husbandry, report of	179
Extension work, report of the division of	155
Extension work with potatoes and vegetables, report of	172

F.

Faculty and other officers, list of	7-12
Farm crops, report of the department of	47
Farm crops section, report of the	280
Farm mechanics, report of the department of	52
Farm mechanics section, report of the	285
Feeding stuffs, analyses of	330-399
Fertilizer analyses, bulletin No. 287	435
Foreign nurseries licensed in Michigan	136-137
Forestry, report of the department of	54
Forestry section, report of the	286
Further studies on the pathology of the reproductive organs in sterility	288

G.

Graham horticultural experiment station, report of	279
Griswold scholarship, Marilla	19

H.

History and political science, report of the department of	106
Home demonstration agents, list of	15
Home demonstration agent work, report of	191
Horticultural section, report of the	278
Horticulture, report of the department of	43
Household arts department, report of the	72

I.

Income of Michigan Agricultural College from all outside sources, from the date of its foundation to the present time	36-37
Increasing the production of the bearing apple orchard, circular No. 43	574
Insecticide and fungicide inspection, report of	269
Inventory, June 30, 1920, summary of college	38-39
Inventory, summary of experiment station	40

L.

Lawson memorial prize, George E.	19
Lecanum, technical bulletin No. 48	663
Liberal arts council, annual report of the	137
Librarian, report of the	109
List of county agricultural agents	14-15
List of experiment station workers	12
List of faculty and other officers	7-12
List of home demonstration agents	15
List of nurseries licensed in Michigan for year ending June 30, 1920	132-135

M.

Mathematics, report of the department of	99
Mechanical engineering, report of the department of	63
Members of standing committees of state board of agriculture	5
Members of the state board of agriculture, list of	5
Meteorological tables	143-154
Meteorology, report of the department of	139
Michigan dealers in nursery stock	135-136
Michigan state agricultural society, annual report and audit and examination	203
Michigan weather service	138
Military science, report of the department of	120
Music department, report of the	122

P.

Pay roll dated June 30, 1921, positions and salaries as shown by	25-31
Physical training, report of the department of	123
Physics, report of the department of	107
Poultry husbandry, report of the department of	51
Poultry section, report of	303

R.

	Page
Registrar, report of the	112
Report of boys' and girls' club work	194
Report of extension specialist in poultry	181
Report of extension work in apiculture	177
Report of extension work in entomology	176
Report of extension work in farm crops	164
Report of extension work in forestry	178
Report of extension work in home economics	183
Report of extension work in horticulture	170
Report of extension work in muck crops	174
Report of extension work in poultry husbandry	179
Report of extension work with potatoes and vegetables	172
Report of Graham horticultural experiment station	279
Report of home demonstration agent work	191
Report of insecticide and fungicide inspection	269
Report of Michigan weather service	138
Report of secretary and treasurer of the experiment station	228
Report of summer school	117
Report of the alumni recorder	124
Report of the bacteriological section	231
Report of the botanical section	262
Report of the chemical section	267
Report of the dean of agriculture	41
Report of the dean of engineering	57
Report of the dean of home economics	72
Report of the director of the experiment station	229
Report of the department of agricultural education	55
Report of the department of animal husbandry	50
Report of the department of animal pathology	81
Report of the department of bacteriology	90
Report of the department of botany	94
Report of the department of chemistry	95
Report of the department of civil engineering	59
Report of the department of dairy husbandry	45
Report of the department of drawing and design	67
Report of the department of economics	105
Report of the department of electrical engineering	66
Report of the department of English and modern languages	96
Report of the department of entomology	102
Report of the department of farm crops	47
Report of the department of farm mechanics	52
Report of the department of forestry	54
Report of the department of history and political science	106
Report of the department of horticulture	43
Report of the department of household arts	72
Report of the department of mathematics	99
Report of the department of mechanical engineering	63
Report of the department of meteorology	139
Report of the department of physical training	123
Report of the department of physics	107
Report of the department of poultry husbandry	51
Report of the department of soils	49
Report of the department of surgery and clinic	83
Report of the department of zoology and physiology	100
Report of the division of extension work	155
Report of the division of veterinary science	75
Report of the extension specialist in dairying	168
Report of the farm crops section	280
Report of the farm mechanics section	285
Report of the forestry section	286
Report of the horticultural section	278
Report of the liberal arts council	137
Report of the librarian	109
Report of the military department	120
Report of the music department	122
Report of the poultry section	303
Report of the registrar	112
Report of the secretary of the state board of agriculture	4
Report of the section of animal husbandry	230
Report of the section of animal pathology	287
Report of the soils section	284
Report of the specialist in poultry	181
Report of the state inspector of apiaries	103
Report of the state inspector of nurseries and orchards	127
Report of the Upper Peninsula experiment station	304
Report, secretary's financial	16
Reports, table I, tabular exhibit of secretary's	17

S.

Salaries experiment station, fiscal year ending June 30, 1920	32
Salaries, extension, fiscal year ending June 30, 1920, summary of	33-35
Sayer scholarship fund, William Smith	19
Secretary and treasurer of experiment station, report of	288
Secretary of the state board of agriculture, report of the	4

	Page
Secretary's financial report.....	16
Short season hay crops, circular No. 42.....	571
Soils, report of the department of.....	49
Soils section, report of the.....	284
Soy beans, special bulletin No. 100.....	546
Special appropriations accounts for fiscal year ending June 30, 1920, statement of.....	18
Special bulletin No. 98, directions for making a good flavored cider vinegar.....	495
Special bulletin No. 99, the Detroit commission plan of city milk administration.....	520
Special bulletin No. 100, soy beans.....	546
Specialists in boys' and girl's club work.....	15
Standing committees, members of.....	5
State board of agriculture, members of.....	5
State inspector of nurseries and orchards, report of the.....	127
State laws governing the protection and planting of street trees.....	563
Statement of special appropriations accounts for fiscal year ending June 30, 1920.....	18
Station council, members of.....	13
Studies in the cost of milk production, bulletin No. 286.....	400
Studies in the heat resistant organisms of cold packed canned peas, technical bulletin No. 47.....	633
Summary of experiment station inventory.....	40
Summary of college inventory.....	38-39
Surgery and clinics, report of the department of.....	83
T.	
Table I, tabular exhibit of secretary's report.....	17
Table II, statement of special appropriations accounts for the fiscal year ending June 30, 1920.....	18
Table III, William Smith Sayer scholarship fund.....	19
Table IV, George E. Lawson memorial prize.....	19
Table V, George L. Allen scholarship.....	19
Table VI, Marilla Griswold scholarship.....	19
Table VII, current account July 1, 1919, to June 30, 1920.....	20-21
Table VIII, experiment station account for fiscal year ending June 30, 1920.....	23
Table IX, extension account for fiscal year ending June 30, 1920.....	24
Table X, positions and salaries as shown by pay-roll dated June 30, 1920.....	25-31
Table XI, salaries experiment station, fiscal year ending June 30, 1920.....	32
Table XII, salaries extension, fiscal year ending June 30, 1920.....	33-35
Table XIII, income of Michigan Agricultural College from all outside sources from the date of its foundation.....	36-37
Technical bulletin No. 45, the effect of fertilizer salts treatments on the composition of the soil extracts.....	590
Technical bulletin No. 46, the use of solutions of ammonium citrate for the estimation of reverted calcium phosphate.....	606
Technical bulletin No. 47, studies in the heat resistant organisms of cold packed canned peas.....	633
Technical bulletin No. 48, lecanium.....	663
The effect of fertilizer salts treatments on the composition of the soil extracts, technical bulletin No. 45.....	590
Thirty-third report of the experiment station of Michigan Agricultural College.....	227
Treasurer's account.....	17
U.	
Upper Peninsula experiment station, report of the.....	304
V.	
Veterinary science, report of the division of.....	75
X, Y, Z.	
Zoology and physiology, report of the department of.....	100

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